

Regional Carbon Sequestration Partnership Kickoff Meeting

Proceedings



Hyatt Regency at the Pittsburgh Airport

November 3-4, 2003



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Proceedings from
Regional Carbon Sequestration Partnership Kickoff Meeting
Pittsburgh, PA

November 3-4, 2003

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MEETING SUMMARY

INTRODUCTION

The DOE recently selected seven regional teams to help develop the framework and infrastructure needed for wide scale deployment of carbon sequestration technologies, should they be needed. A kick-off meeting was held in Pittsburgh, Pennsylvania, on November 3-4, with representatives from DOE and all seven of the partnerships. The purpose of the meeting was to bring the representatives from the Regional Carbon Sequestration Partnerships together to brief DOE on their project plans, goals, and partnership composition. Six parallel breakout sessions were held in the morning of the second day to strategize approaches and identify synergistic opportunities among the partnerships. Breakout topics included regulatory compliance, public outreach and education, capture and separation technologies, geologic sequestration requirements, terrestrial sequestration requirements, as well as geographic information system and database development.

BACKGROUND

The forecasted growth in the use of fossil fuels in this century means a rising concentration of carbon dioxide (CO₂) in the atmosphere unless mitigating steps are undertaken. The Global Climate Change Initiative (GCCCI) calls for an 18% reduction in the carbon intensity (the ratio of greenhouse gas emissions to economic output) of the United States by 2012. Technological solutions that provide energy-based goods and services with reduced greenhouse gas (GHG) emissions are the preferred approach to achieving GCCCI's goal. GCCCI also calls for a progress review in 2012 relative to the goal of the initiative, at which time decisions will be made about additional implementation measures for mitigating GHG emissions. By focusing on GHG intensity as the measure of success, this strategy promotes vital climate change R&D while minimizing the economic impact of GHG stabilization on the U.S.

In 1992, the U.S. and 160 other nations ratified the Rio Treaty, which calls for "...stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The appropriate level of GHGs in the atmosphere is still open to debate, but even modest stabilization scenarios suggest an eventual reduction in worldwide GHG emissions of 50-90% below current levels.

The requirement for GHG emissions reduction could be very large in the next 20 years or so; and if the potential for sequestration can be realized, the cost of CO₂ emissions mitigation can be significantly reduced. In the last five years, sequestration research at DOE's Fossil Energy Department, through the National Energy Technology Laboratory, has progressed from small-scale, largely conceptual studies to one of the highest priorities in DOE's RD&D program. Figure 2 depicts the research elements in the sequestration program plan. The three major elements in this plan are: core R&D infrastructure, and integration.

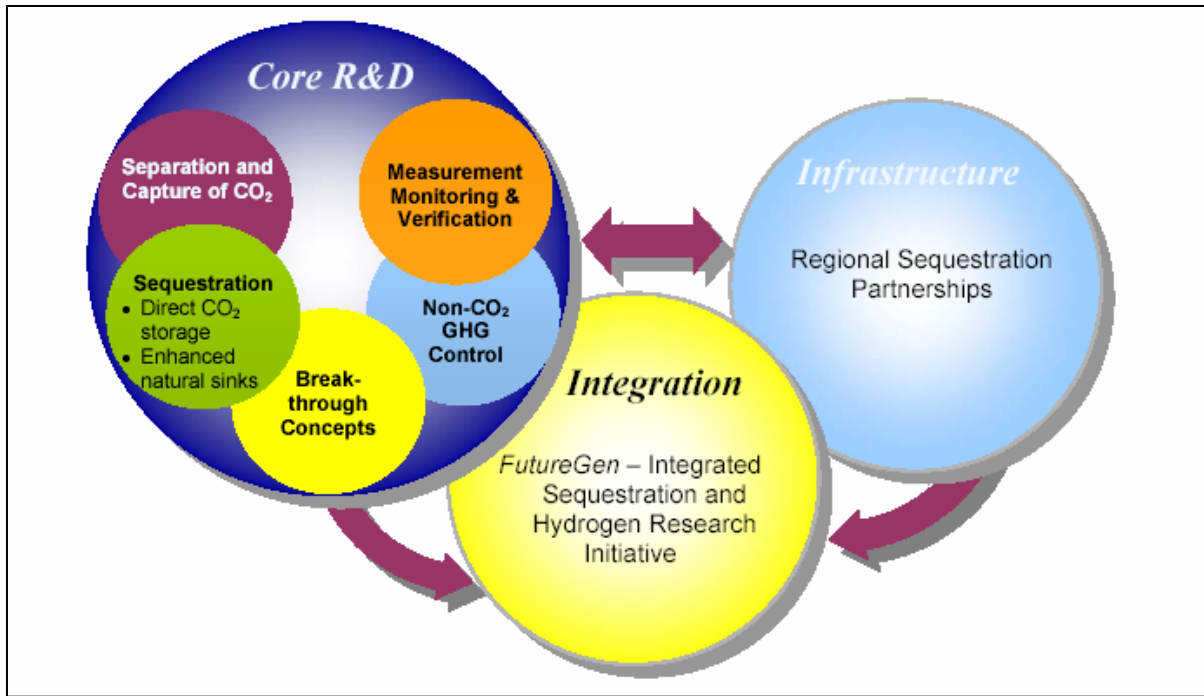


Figure 2. Carbon Sequestration Technology Roadmap and Program Plan

Core R&D

Major areas of investigation of the Core R&D program element are:

- Separation and Capture targets novel, low-cost approaches for the capture of carbon or CO₂ from energy production and conversion systems.
- Direct Geologic Sequestration assesses the applicability and effectiveness of long-term CO₂ storage in geologic structures, such as depleted oil and gas reservoirs, unmineable coal seams, and deep saline aquifers.
- Enhanced Natural Sinks examines the potential to enhance terrestrial uptake and increase the retention of CO₂ from the atmosphere by coupling improved agricultural and forestry practices with fossil-energy production and use.
- Measurement, Monitoring, and Verification (MMV) investigates the capability to measure the amount of CO₂ stored at a specific sequestration site, to monitor the site for leaks or other deterioration of storage integrity over time, and to verify that the stored CO₂ is not harmful to the host ecosystem. MMV technology will ensure safe, permanent storage; reduce the risk associated with buying or selling credits for sequestered CO₂; help satisfy regulators and local government officials who must approve large sequestration projects; and provide valuable feedback for continuous refinement of injection and management practices.
- Non-CO₂ Greenhouse Gases is focused on areas where non-CO₂ GHG abatement is integrated with energy production, conversion, and use, such as mine mouth ventilation methane mitigation and landfill gas recovery. Non-CO₂ GHGs, such as methane, nitrous oxide, and other gases with high global warming potential, generally have high economic value and can often be captured, or their release avoided, at low net cost. This program is working with the U.S. Environmental Protection Agency (EPA) to assess the role that non-CO₂ GHG emissions

abatement can play in reducing GHG emissions intensity and to identify priority areas for RD&D.

- Breakthrough Concepts is pursuing revolutionary approaches with potential for low cost, high performance, and large capacity sequestration. A guiding principle is to mimic and harness processes found in nature, such as photosynthesis and mollusk shell formation, that convert CO₂ to another carbonaceous substance. A priority area of study is subsurface CO₂ conversion to enhance geologic sequestration.

Infrastructure

The Infrastructure program element is aimed at promoting the development of the infrastructure necessary to implement large scale CO₂ sequestration. A major thrust is the establishment of Regional Partnerships of governmental, academic, industrial, and nonprofit organizations. DOE has created a nationwide network of seven partnerships to help determine the technology, regulations, and infrastructure most appropriate to promote CO₂ capture, storage and sequestration in different areas of the U.S. These seven partnerships will develop the framework needed to validate and potentially deploy carbon sequestration technologies. The partnerships will study which of the numerous sequestration approaches that have emerged in the last few years are best suited for their specific regions of the country. They will also begin studying possible regulations and the infrastructure requirements that a region would need should climate science dictate that sequestration be deployed on a wide scale in the future. The regional partnerships will use information from the Core R&D program to help select the most promising technologies for deployment. Results of the Regional Partnerships will be used to support the integration portion of the Sequestration program. Approaches to public outreach, regulatory compliance, as well as identifying the most promising technologies for capture, sequestration and monitoring will likely be integrated in the FutureGen project.

Integration

Integration involves bringing together the diverse elements of the various RD&D programs to produce a cutting edge project that generates nearly pollution free energy. DOE is sponsoring the FutureGen Initiative, a ten-year demonstration project to create the world's first coal-based, zero-emissions power plant to produce electricity and hydrogen. Virtually every aspect of the FutureGen project will employ cutting-edge technology. Rather than using traditional coal combustion technology, the 275 MW prototype plant will be based on coal gasification, in which the coal's carbon is converted to a synthesis gas, consisting primarily of hydrogen and carbon monoxide. Advanced technology will be used to react the synthesis gas with steam to produce additional hydrogen and a concentrated stream of CO₂. Initially, the hydrogen will be used as a clean fuel for electric power generation, either in turbines, fuel cells, or hybrid plants. The hydrogen could also be supplied as a feedstock for refineries. In the future, as hydrogen-powered automobiles and trucks are developed, the plant could be a source of transportation-grade hydrogen fuel.

The captured CO₂ will be separated from the hydrogen, perhaps by novel membranes or other technologies currently under development. The CO₂ would then be permanently sequestered in a geologic formation, such as a depleted oil and gas reservoir, an

unmineable coal seam, a deep saline aquifer, or a basalt formation. All these formations are common throughout the U.S.

MEETING OUTLINE

The one-and-a-half day kickoff meeting workshop brought together sixty-four (64) representatives from the Regional Partnerships representing federal and state governments, academia, national laboratories, utilities, energy industry, and regulatory agencies. The objective of the workshop was to brief DOE personnel on the scope of work, work plans, and partnership composition as well conduct organized breakout sessions for representatives from all the partnerships to discuss approaches to similar issues. Carl Michael Smith, ASFE, provided welcoming remarks in his keynote address that stressed the importance of the initiative and how this work supports the President's Global Climate Change Initiative and other key Departmental initiatives such as FutureGen and the Carbon Sequestration Leadership Forum. Scott Klara, the NETL Carbon Sequestration Technology Manager, presented an overview of the Department's Sequestration Program and the desired goals for the Regional Partnerships. Representatives from each Partnership gave presentations that summarized their approaches to characterize their geographic regions for potential sequestration opportunities, to develop methods to conduct public outreach and education, and to evaluate the regulatory requirements to permit potential projects. The representatives of the partnerships presenting at the meeting and the title of their partnerships are listed below:

Title	Presenter	Organization
West Coast Regional Carbon Sequestration Partnership	Terry Surles	California Energy Commission
An Assessment of Geological Carbon Sequestration Options in the Illinois Basin	Robert Finley	Illinois State Geological Survey – University of Illinois
Midwest Regional Carbon Sequestration Partnership	Ronald Cudnik	Battelle Memorial Institute - Columbus Operations
Southeast Regional Carbon Sequestration Partnership	Kenneth Nemeth	Southern States Energy Board
Southwest Regional Partnership for Carbon Sequestration	Brian McPherson	New Mexico Tech
Northern Rockies and Great Plains Regional Carbon Sequestration Partnership	Susan Capalbo	Montana State University - Bozeman
Plains CO2 Reduction Partnership	Tom Erickson	Energy and Environmental Research Center

BREAKOUT SESSIONS

Six parallel breakout sessions were held in the morning of the second day was committed to structured breakout sessions to strategize approaches and identify synergistic opportunities among the partnerships. Breakout topics included regulatory compliance, public outreach and education, capture and separation technologies, geologic sequestration requirements, terrestrial sequestration requirements, as well as geographic information system and database development.

Topics for each of the breakout sessions had been submitted by the Regional Partnerships. The groups were to discuss each of these topics discussion points and the discussion transcribed during the session. A facilitator was designated prior to the meeting to organize the discussion, ensure that ground rules were covered, and reach consensus whether new topics should be discussed that were germane to the session topics. For each breakout session, a presentation was then developed based on the most significant issues covered by the group. The presentations were delivered by a representative from each group during the afternoon session for further discussion. The following are the titles of the breakout sessions attended by the Partnerships representatives.

- *Regulatory Compliance and Liability Issues*
- *Public Education and Outreach*
- *Capture and Separation Technologies*
- *Geologic Sink Characterization and Infrastructure Requirements*
- *Terrestrial Sink Characterization and Infrastructure Requirements*
- *GIS and Database Development*

Visit NETL's Carbon Sequestration Website at:
<http://www.netl.doe.gov/coalpower/sequestration/index.html>



U.S. Department of Energy

National Energy Technology Laboratory



Dear Colleague:

You and the members of your Carbon Sequestration Partnership team are cordially invited to participate in the U.S. Department of Energy's (DOE's) National Energy Technology Laboratory's (NETL) kickoff meeting for the Regional Carbon Sequestration Partnerships awards. Please forward this letter to individuals in your partnership you would like to participate in the breakout sessions listed in the attached agenda. The meeting will be held on November 3-4, 2003, at the Hyatt Regency Pittsburgh International Airport. The Carbon Sequestration Regional Partnerships consist of seven awardees representing the interests of over 140 organizations, 33 states, several Indian Nations, and 2 Canadian provinces that will be researching the deployment of carbon sequestration technologies in their respective regions.

This meeting will provide an opportunity for each of the Regional Carbon Sequestration Partnerships to brief the DOE and network with representatives from other partnerships that will be addressing similar issues. The meeting will start with a program session in which DOE will present an overview of the carbon sequestration program and expectations of the Regional Carbon Sequestration Partnerships Program. Each partnership will then present an overview of the goals, strategies, composition, and project plan that will be used toward developing carbon sequestration implementation plans in their region. Breakout session that address key issues facing all the partnerships will follow. Members of the partnership should be represented in each of these breakout sessions. The meeting will close with another general session in which the results of each breakout group will be presented.

Enclosed with this letter of invitation is the registration material for the workshop, along with an agenda, and a description of the topics for planned breakout sessions. When registering, please indicate your preference of the breakout sessions. NETL is giving the partnerships the opportunity to provide input to the scope of the breakout discussions. Therefore, please provide one or two issues your partnership has for topics of discussion during each of the breakout sessions. Please email the completed list of suggested discussion issues by October 15th, 2003 to John.Litynski@netl.doe.gov. Other participants from your partnership should also indicate their breakout session preference and the partnership they are representing. Each partnership should limit the number of participants to seven (7) or less.

To register for this meeting, please complete the attached registration form. The cost of the meeting is \$80. A block of rooms have been set aside for this meeting. Reservations can be made by calling, 724-899-1234. Please mention the "U.S. Department of Energy" when making your reservations.

Your participation is needed to help DOE and its stakeholders investigate the potential of deploying carbon sequestration technologies in the United States to help mitigate the impacts of carbon emissions on global climate change.

Regional Carbon Sequestration Partnership Kickoff Meeting

Hyatt Regency at the Pittsburgh Airport

AGENDA

DAY 1 - NOVEMBER 3

- 7:30–8:30 **Registration**
- 8:30–8:45 **Welcoming Remarks**
Carl Michael Smith, Assistant Secretary for Fossil Energy
- 8:45–9:00 **Introductions**
- 9:00–9:25 NETL Carbon Sequestration Technology Program and Regional Partnerships
Scott Klara, Carbon Sequestration Technology Manager
- 9:25–9:50 **Plenary Discussion** — Program Goals of the Regional Partnerships
- 9:50–10:00 **Break**
- 10:00–10:45 West Coast Regional Carbon Sequestration Partnership
Terry Surles, California Energy Commission
- 10:45–11:30 An Assessment of Geological Carbon Sequestration Options in the Illinois Basin
Robert Finley, Illinois State Geological Survey — University of Illinois
- 11:30–12:30 **Lunch** (Provided)
- 12:30–1:15 Midwest Regional Carbon Sequestration Partnership
Ronald Cudnik, Battelle Memorial Institute — Columbus Operations
- 1:15–2:00 Southeast Regional Carbon Sequestration Partnership
Kenneth Nemeth, Southern States Energy Board
- 2:00–2:45 Southwest Regional Partnership for Carbon Sequestration
Brian McPherson, New Mexico Tech
- 2:45–3:00 **Break**



Each partnership presents for thirty-five minutes with a ten minute question and answer period.

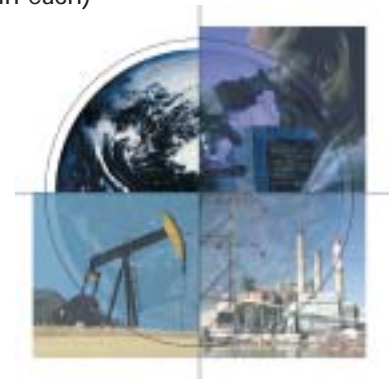


DAY 1 - NOVEMBER 3 (CONTINUED)

- 3:00–3:45 Northern Rockies and Great Plains Regional Carbon Sequestration Partnership
Susan Capalbo, Montana State University — Bozeman
- 3:45–4:30 Plains CO₂ Reduction Partnership
Tom Erickson, Energy and Environmental Research Center
- 4:30–4:45 **Closing Remarks and Discuss Agenda for Day 2**
- 4:45–6:00 **Reception**

DAY 2 - NOVEMBER 4

- 8:00–8:30 **Welcome and Goals of Today's Meeting**
- 8:30–11:00 **Breakout Sessions**
- *Regulatory Compliance and Liability Issues*
 - *Public Education and Outreach*
 - *Capture and Separation Technologies*
 - *Geologic Sink Characterization and Infrastructure Requirements*
 - *Terrestrial Sink Characterization and Infrastructure Requirements*
 - *GIS and Database Development*
- 11:00–12:00 Groups summarize comments internally
- 12:00–1:00 **Lunch** (Provided)
- 1:00–2:30 Group representatives present findings from sessions (15 min each)
- 2:30–2:45 **Closing Remarks**



Appendix A

SESSION 1: REGULATORY COMPLIANCE AND LIABILITY ISSUES

Name of Partnerships Session Participants and Organizations:

Larry Bengal, Illinois Department of Natural Resources, IOGCC (Facilitator)
Jennifer White, SAIC/NETL (Scribe)
Richard Benson, Los Alamos National Laboratory
Kelly Birkinshaw, California Energy Commission
Patrick R. Esposito II, Augusta Systems
John Harju, Energy and Environmental Research Center
Raymond W. Lawton, National Regulatory Research Institute
Brian McPherson, New Mexico Institute of Mining and Technology
John Rupp, Indiana State Geological Survey

Suggested Issues for Discussion During Breakout Session:

1. What are the major national statutes that will/could govern geologic sequestration in the different geologic sinks (EOR, saline aquifers, ECBM, others)? There will be gaps in regulation on a national and state level, how should these gaps be addressed during Phase I?
2. What roles should the different stakeholders (Government Regulators, Private Industry, Academics, and NGOs (Environmental and Business related)) play in the development of regulations for carbon sequestration?
3. Who will be responsible for injected CO₂ and who will be potentially liable for future activities in zones influenced by geologic sequestration?
4. How should the partnerships approach the issue of carbon or GHG trading markets and interface with existing organization developing trading markets? In forming regional action plans for accounting frameworks, what should the relationship between 1605(b) reporting structures and potential regional specific accounting frameworks be?

Please set aside 10 to 15 minutes to answer the following questions. Your responses will help DOE as we develop follow on meetings with the regional partnerships and other stakeholders.

What other sessions did this overlap with?

Would your group suggest to organize the breakout session differently (combine, add or delete sessions)?

Would additional meetings of this group help to solve some of the issues that arose today? If so, how often: Quarterly, Semi Annual, Annual?

Other Issues?



SESSION 2: PUBLIC OUTREACH AND EDUCATION

Name of Partnerships Session Participants and Organizations:

Sarah Wade, Keystone Center (Facilitator)
Chris Mahoney, SAIC/NETL (Scribe)
Judith Bradbury, Battelle Pacific Northwest Division
Dave Curtiss, University of Utah
Dan Daly, Energy and Environmental Research Center
Martha Krebs, Science Startegies
Hannes Leetaru, Illinois State Geological Survey
Kenneth Nemeth, Southern States Energy Board
Pamela Tomski, EnTech Strategies

Suggested Issues for Discussion During Breakout Session:

1. Should regional partnerships concentrate public education and outreach to target audiences (decision makers, educators, etc) or should the approach be more general such as television advertisements, or should a combination of both? Similarly, should partnerships plan to focus on outreach activities on areas where projects are most likely, provide outreach over the entire region, or develop programs that address both needs?
2. To what extent has existing research assessed different groups of interested stakeholders and the level of awareness, concerns, benefits, confidence for each about a) geologic and b) terrestrial sequestration given the current state of the technology? In general, what are the public's likely perceived benefits and issues associated with a) geologic and b) terrestrial sequestration?
3. Given that sequestration seems low on the radar screen, is there a good way to coordinate the actions of seven different partnerships so that the relatively small environmental community is not overwhelmed with efforts to reach out to them?
4. What is available in the form of latest presentation technology and techniques for presenting scientific results for public education and outreach to the wide range of audiences the partnerships will be approaching?
5. How will the public outreach action plan address the public involvement requirements under NEPA and the other state environmental process?

Please set aside 10 to 15 minutes to answer the following questions. Your responses will help DOE develop follow on meeting with the regional partnerships and other stakeholders.

What other sessions did this overlap with?

Would your group suggest to organize the breakout session differently (combine, add or delete sessions)?

Would additional meetings of this group help to solve some of the issues that arose today? If so, how often: Quarterly, Semi Annual, Annual?

Other Issues?



SESSION 3: CAPTURE AND SEPARTATION TECHNOLOGIES

Name of Partnerships Session Participants and Organizations:

Chuck Schmidt, Science Application International Corporation (Facilitator)
Erik Shuster, SAIC/NETL (Scribe)
Tom Erickson, Energy and Environmental Research Center
Scott Frailey, Illinois State Geological Survey
Neeraj Gupta, Battelle Columbus Operations
Howard S. Meyer, Gas Technology Institute
Mark Musich, Energy and Environmental Research Center
John Plodinec, Mississippi State University
David Shropshire, Idaho National Engineering and Environmental Laboratory
John Ruby, Nexant, Inc.

Suggested Issues for Discussion During Breakout Session:

1. Discuss how the purity of CO₂ will affect each of the different aquifer and capture requirements? Is there need for a national system to report this information or are these regional concerns?
2. What are effects of oxygen, fly ash on chemical solvents (degradation) on the capture systems and how will it affect cost/design at full scale operation?
3. How is each of the partnerships defining the sources of CO₂ in their region (type, size, fuure plants, etc)? Is there need or a need for uniform classification system or are regional approaches beneficial?
4. How do we handle the limited number of CO₂ control options that may be available or ready for testing in the time frame of this effort?

Please set aside 10 to 15 minutes to answer the following questions. Your responses will help DOE develop follow on meeting with the regional partnerships and other stakeholders.

What other sessions did this overlap with?

Would your group suggest to organize the breakout session differently (combine, add or delete sessions)?

Would additional meetings of this group help to solve some of the issues that arose today? If so, how often: Quarterly, Semi Annual, Annual?

Other Issues?



SESSION 4: GEOLOGIC SINK CHARACTERIZATION AND INFRASTRUCTURE REQUIREMENTS

Name of Partnerships Session Participants and Organizations:

Larry Myer, University of California Office of the President, (Facilitator)
Howard McIlvried, SAIC/NETL (Scribe)
Patrick Esposito, Augusta Systems
Rob Finley, Illinois State Geological Survey
Susan Hovorka, Texas Bureau of Economic Geology
Travis McLing, Idaho National Engineering and Environmental Laboratory
James Sorensen, Energy and Environmental Research Center
Larry Wickstrom, Ohio Division of Geological Survey

Suggested Issues for Discussion During Breakout Session:

1. What are benefits and risks to having each of the regions evaluate their geologic sinks separately? Is there a need for coordination between the regions and DOE, and why?
2. From a practical standpoint, does infrastructure equate to pipelines? At what point should a partnership investigate, in greater depth, other transportation options in the course of infrastructure requirements research, including, among others, railroads, trucks, and barges?
3. All potential sequestration reservoirs will need to be screened and classified, according to a variety of characteristics to determine which are the best candidates for CO₂ sequestration. What are the factors and calculations that need to be considered, and will a uniform or regional approach be best to develop this system(s)?
4. What risks are involved with geologic sequestration and how should it be incorporated into assessments of source-sink options?

Please set aside 10 to 15 minutes to answer the following questions. Your responses will help DOE develop follow on meeting with the regional partnerships and other stakeholders.

What other sessions did this overlap with?

Would your group suggest to organize the breakout session differently (combine, add or delete sessions)?

Would additional meetings of this group help to solve some of the issues that arose today? If so, how often: Quarterly, Semi Annual, Annual?

Other Issues?



SESSION 5: TERRESTRIAL SINK CHARACTERIZATION AND INFRASTRUCTURE REQUIREMENTS

Name of Partnerships Session Participants and Organizations:

Susan Capalbo, Montana State University (Facilitator)
Jeff Hoffmann, SAIC/NETL (Scribe)
George Guthrie, Los Alamos National Laboratory
Gerald R. Hill, Southern States Energy Board
John Kadyszewski, Winrock International
Rattan Lal, The Ohio State University
Larry Leistritz, North Dakota State University
Pat Zimmerman, South Dakota School of Mines and Technology

Suggested Issues for Discussion During Breakout Session:

1. From the results of the Phase I projects, how can the partnerships reach consensus and influence policy requirements for terrestrial carbon sequestration projects?
2. What are some innovative approaches to bringing about change in human behavior (conventional to no-till agriculture) to increase carbon sequestration and how can the partnerships influence these changes?
3. What databases could be used to describe land use/ land cover and soil types for the various regions? How are the partnerships going to assess and assemble information on the impact of land use and management practices on terrestrial carbon pools?
4. How should you assess the extent and severity of soil degradation (e.g., erosion, abandoned mine lands) on lands in the regions and how will we assess the impact of the restoration of these lands on terrestrial carbon pools?
5. What are the risks associated with terrestrial sequestration and how should they be accounted for in establishing carbon offsets for terrestrial sequestration?

Please set aside 10 to 15 minutes to answer the following questions. Your responses will help DOE develop follow on meeting with the regional partnerships and other stakeholders.

What other sessions did this overlap with?

Would your group suggest to organize the breakout session differently (combine, add or delete sessions)?

Would additional meetings of this group help to solve some of the issues that arose today? If so, how often: Quarterly, Semi Annual, Annual?

Other Issues?



SESSION 6: GIS/DATABASE DEVELOPMENT

Name of Partnerships Session Participants and Organizations:

Tim Carr, Kansas State Geological Survey (Facilitator)
Jared Ciferno, SAIC/NETL (Scribe)
James J. Dooley, Battelle Pacific Northwest Division
Chris Korose, Illinois State Geological Survey
Randy Lee, Idaho National Energy and Environmental Laboratory
Dennis Goreham, Utah AGRC
Erin O'Leary, Energy and Environmental Research Center
Maribeth Price, South Dakota School of Mines and Technology
Richard Rhudy, Environmental Power Research Institute
Ed Steadman, Energy and Environmental Research Center

Suggested Issues for Discussion During Breakout Session:

1. Many of the sources of data available have data stored in different formats and units and are updated at various times. How do we simplify the process of integrating this information into the GIS systems and keeping it updated?
2. Should there be a standard set of software, units, types of data related to emission points, infrastructure, and sinks, projection system that should be adopted? Should there be a working group or entity responsible for setting these?
3. Available data is usually extrapolated from point data. How do we assure the quality of the available data is sufficient for the geologic storage option? How do we handle situations where no data is available?
4. How can the partnerships incorporate the expertise and experience from existing databases and GIS such as the MIDCARB and MIT projects so that a US system is developed. This would include identification of goals and project components that are common among the different partnerships to support efforts toward cooperative database design?
5. Are there potential national security or other issues (proprietary data, etc.) involving the compilation, display, and dissemination of industrial and/or infrastructural data and how should that be managed?

Please set aside 10 to 15 minutes to answer the following questions. Your responses will help DOE develop follow on meeting with the regional partnerships and other stakeholders.

What other sessions did this overlap with?

Would your group suggest to organize the breakout session differently (combine, add or delete sessions)?

Would additional meetings of this group help to solve some of the issues that arose today? If so, how often: Quarterly, Semi Annual, Annual?

Other Issues?



Regional Carbon Sequestration Partnership Kickoff Meeting: Summary of Breakout Sessions

Breakout Session 1: Regulatory Compliance and Liability Issues

The Regulatory Compliance and Liability Issues Breakout Session was attended by representatives from each regional partnership and DOE and facilitated by Larry Bengal of the Illinois Department of Natural Resources and the coordinator for IOGCC's efforts with several of the Regional Partnerships. The group addressed regulatory concerns relating to several major topics: crosscutting issues, capture and separation, transportation, sequestration methods, and coal, geological and terrestrial sequestration. The group agreed that the definition of CO₂ as a product, waste, or pollutant is one of the most important issues that will guide policy and regulation. If states choose to classify CO₂ in different ways, interstate problems could arise, so coordination between states and regions would be helpful. A streamlined process for regulation within and between the states will also help to ease project implementation. For capture and separation, the group discussed potential differences between existing facilities and new facilities. Although they will face many of the same issues, new facilities must deal with additional permitting and siting concerns and unknown health and safety issues of the capture and compression processes. For carbon sequestration to be implemented on a large scale, a transportation infrastructure will be needed. There is currently insufficient capacity for CO₂ transportation, and there is not central regulatory process to manage new pipeline construction. Although this is largely in the hands of states, the involvement by the federal government may also be needed because of the vast amount of public lands, especially in the Western United States. Current regulations for enhanced oil recovery (EOR) may apply to carbon sequestration or provide a model for new regulations. The group also agreed that it may be beneficial to have a new classification for CO₂ injection wells under Underground Injection Control (UIC) regulations. Liability issues relating to surface and mineral rights will all need to be addressed in both long- and short-term contexts. Finally, the breakout session participants agreed that it's important to "get ahead of the game" so that the scientific results of the sequestration program can be used to help shape objective carbon sequestration regulations. The group members also discussed the desire for further contact between the partnerships to continue discussing regulatory issues.

Breakout Session 2: Public Education and Outreach Breakout Session

The Public Education and Outreach Breakout Session was attended by representatives from each regional partnership and DOE and facilitated by Sarah Wade, Keystone Center and member of the Midwest Regional Partnership. The group focused on many areas of general discussion that affect all of the regional partnerships. The group agreed that there are several federal, state, and privately financed sequestration projects and there is a need for coordination between these major efforts to ensure a consistent public message. Many of these projects have existing frameworks for public outreach that may be beneficial to the partnerships and should be pursued. The group identified the need to develop a sequestration message that addresses perceptions about the differences between terrestrial and geologic sequestration. In addition to educating the public about sequestration, the group also felt that development of consistent umbrella outreach materials covering the basics of energy and CO₂ generation is needed to give context to sequestration. The public is unaware of the major issues related to electricity generation, climate change, and sequestration. The group also recognized the need to have some consistency in the partnerships' messages concerning the goals and activities being conducted during Phase I and potential Phase II projects. It was clear to the group that the coordination between the groups was necessary so that they could leverage the efforts from each other and ensure that a certain level of consistency was maintained in the messages generated from each partnership. A final insight made by the group was the need for a Programmatic Environmental Impact Statement (PEIS) that could aid in educating and engaging the public in deployment of sequestration. Scott Klara, NETL, mentioned that DOE is in the initial stages of developing a PEIS for the sequestration program. The DOE would be able to provide more details at subsequent meetings.

Breakout Session 3: Capture and Separation Technologies

The Capture and Separation Technologies Breakout Session was attended by representatives from each regional partnership and DOE and facilitated by Chuck Schmidt, NETL/SAIC. The group strongly agreed there needs to be a national system to report CO₂ sources according to region, amount of CO₂ generated, industry type, plant performance, and plant technology as well as a standard reporting system for recording and reporting this data. The target for CO₂ capture should be set high (~100%). Purity of the CO₂ to be captured will have to be high due to the strict design criteria placed on today's capture systems and there is limited information on the interaction of impurities with the sinks. Today's capture technologies will have to be used for Phase II. Therefore, it was the opinion of the group that limited coal-fired sources would be a part of the Phase II effort. The group agreed that it would be unlikely that retrofit technology would be a part of Phase II due to costs and complexities of the older system. The group discussed the need to evaluate new source production technologies, such as gasification, and incorporated with the CO₂ capture and separation process. With some discussion of DOE's FutureGEN program and the need for zero emission plants, the group understands that multi-pollutant control systems will be needed along with the CO₂ capture system and must be evaluated during Phase I. All agreed that sequestration will be an integral part of the pathway to zero-emission plants.

Breakout Session 4: Geologic Sink Characterization and Infrastructure Requirements

The Geologic Sink Characterization and Infrastructure Requirements Breakout Session was attended by representatives from each regional partnership and DOE and facilitated by Larry Myer, of the University of California and member of the West Coast Regional Partnership. The participants concluded that geologic sink characterization is very important, and a standardized data input format should be developed, even if not all the data elements are completed for each sink. The group discussed the need to evaluate all possible transportation opportunities. Ideas such as rail ways, transmission line right-of-ways, data requirements and accessibility were discussed. Problems with accessing transportation data due to increased security after 9/11 may require additional safeguards and efforts. The group stressed that each potential regional sequestration site will need to be characterized from multiple viewpoints, including technical, geological, regulatory, public acceptability, site integrity, etc. Screening criteria for potential geologic sequestration sites were discussed that could be used for reservoir selection by not only evaluating physical properties that determined integrity and capacity but incorporated other factors such as cost, regulatory issues, and public acceptance. The group discussed issues related to the risk from geologic sequestration projects and how the partnerships should be addressing each. The group agreed that a national atlas would be a very valuable document, but this is a very significant undertaking and will require a great deal of cooperation and planning. Finally it was stressed that collaboration among partnerships is critical to prevent duplication of effort and to make sure that positive developments by one partnership are made available to all (i.e. share approaches and best practices).

Breakout Session 5: Terrestrial Sink Characterization and Infrastructure Requirements

The Terrestrial Sink Characterization and Infrastructure Requirements Breakout Session was attended by representatives from six of the seven regional partnerships and DOE and facilitated by Susan Capalbo, Montana State University at Bozeman and member of the Northern Rockies and Great Plains Carbon Sequestration Partnership. The breakout session focused on a number of issues and concepts that need to be addressed or resolved for the partnerships to succeed. Several issues were identified related to policy development. These included demonstration of the need for terrestrial sequestration as a tool to meet near-term reductions and longer-term adjuncts to geologic sequestration. Additionally, new policies will need to include consistent, clearly defined guidelines for terrestrial sequestration activities. The group also addressed ways to influence private sector actions such as agricultural activities, and potential barriers to implementation. The partnership representatives discussed data availability and data integrity issues, and agreed that standardized data sets and uniform assumptions would be beneficial. However, it was also acknowledged that some broader, coarse-scale data sets at times are inconsistent with finer-scale, regional data sets. The session participants agreed that risk assessment of various terrestrial sequestration options will likely vary on regional as well as national levels, and those risks should be identified as best as possible. Quantification of risk would be difficult on a large scale, but is necessary at the project level and could influence project location and selection. Other issues identified included data gaps, regional overlap, and regions that are not covered by the various partnerships. Furthermore, the participants noted the importance of considering N₂O and methane emissions, and their relationship to carbon uptake in terrestrial sequestration. The need for cooperation and information exchange was identified as key issues throughout the entire breakout session and covered all topics discussed.

Breakout Session 6: GIS/Database Development

The GIS/Database Development Breakout Session was attended by representatives from each regional partnership and DOE and facilitated by Tim, Carr, Kansas Geological Survey. Since the GIS participants are competitors outside the scope of the regional partnerships, a primary focus of the discussion was on if and how much technology integration should be made between the regions, at the risk of losing important proprietary data or programming techniques. The group focused on integration in terms of consistency from simple data formats (units) to extrapolated and/or calculated data points. The standard formatting and 'sharing' of data is moving towards the development of a national GIS database. Therefore, the participants agreed that at the completion of Phase I, a national GIS database would not only benefit the Carbon Sequestration Technology Program, but would be very beneficial in support of energy policy or technology issues. In addition, deciding on a national GIS database now, forces the regions to standardize formats and will save time and money in the future if a national database is required. Current IT technology is available to efficiently develop a national database using the regional results and the ideal opportunity is now. However, assuring continuity between regions (i.e. national database) is labor intensive, beyond the scope-of-work, and would slow each partnership down with their current objectives. Finally, several other topics were discussed including security concerns, incorporation of GIS community experts, and data quality assurance. The participants voiced confidence that the majority of the issues were 'minor' and solvable. The group stressed the importance of collaboration between partnerships to ensure consistency between systems, models, and data.

Appendix B

Biography - Carl Michael Smith

Carl Michael Smith is the Department of Energy's 9th Assistant Secretary for Fossil Energy. President George W. Bush announced his intent to nominate Mr. Smith on August 17, 2001, and the U.S. Senate confirmed the nomination on January 25, 2002. He was sworn in on February 5, 2002.

As Assistant Secretary, Mr. Smith serves as the primary policy advisor to the Secretary of Energy on federal coal, petroleum and natural gas programs, including extensive research and development efforts.

His responsibilities include overseeing an organization of nearly 1,000 scientists, engineers, technicians, and administrative staff in four field offices and the organization's headquarters in the Washington D.C. area.



Carl Michael Smith

He is responsible for several high-priority Presidential initiatives, including implementation of the Administration's new \$2 billion initiative to develop a new generation of environmentally sound clean coal technologies. His duties also include managing the Nation's Strategic Petroleum Reserve and Northeast Home Heating Oil Reserve, both key emergency response tools available to the President to protect Americans from energy supply disruptions.

Mr. Smith served previously as the State of Oklahoma's Secretary of Energy, an appointment made by Governor Frank Keating in 1995. In this position, he was the Governor's official representative to the Interstate Oil and Gas Compact Commission where he served as its Vice Chairman.

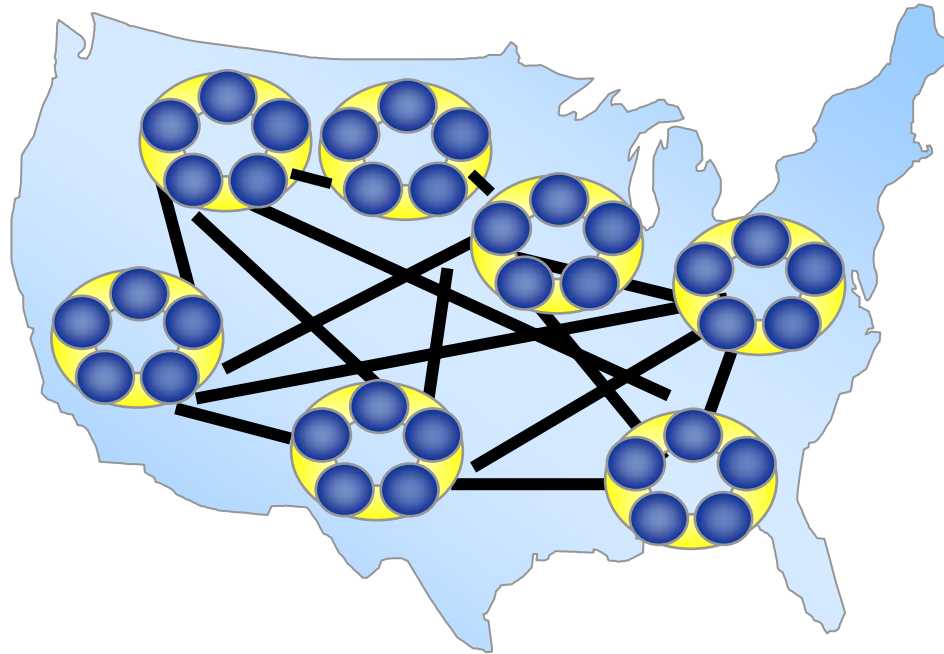
He was also a member of the Interstate Mining Compact Commission and the Governor's Ethanol Coalition. He has also served as chairman of the Southern States Energy Board's Coal and Advanced Power Systems Committee.

Prior to entering State government, Mr. Smith operated an independent oil and gas company in Oklahoma and was a long-standing member of the Oklahoma Independent Petroleum Association. He served on the Association's Board of Directors from 1981 through 1995 and as President in 1994. He has also served on the Board of Directors and as Secretary of the Oklahoma Energy Resources Board from 1992 to 1994.

A native of Oklahoma, he is a graduate of the University of Oklahoma, receiving a Bachelor of Arts degree in 1966 and a Juris Doctor degree from the University's College of Law in 1969.

Mr. Smith served in the United States Army and is a veteran of the Vietnam conflict. He and his wife, Kay, have been married for more than 31 years.

***** Welcome *****



Regional Carbon Sequestration Partnerships

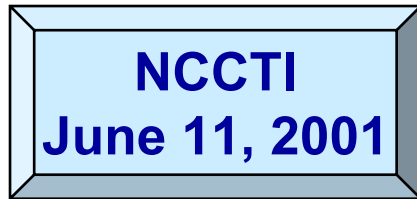
Kick-Off Meeting



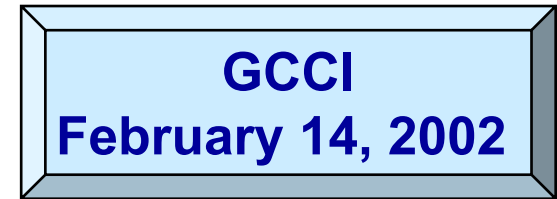
Drivers

Presidential Direction

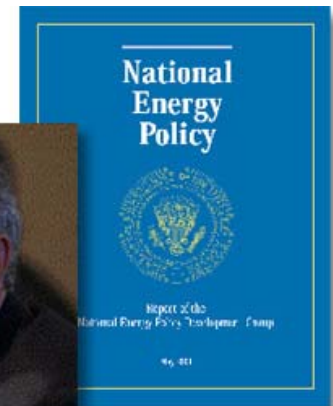
Current Drivers for Carbon Sequestration Program



- Third option for global climate change
- Enables continued use of domestic energy resources and infrastructure
- Geologic formations have potential for essentially unlimited storage capacity
- Demonstrated industry interest, participation, and cost-sharing in public/private partnerships
- “We all believe technology offer great promise to significantly reduce emissions -- especially carbon capture, storage and sequestration technologies.”



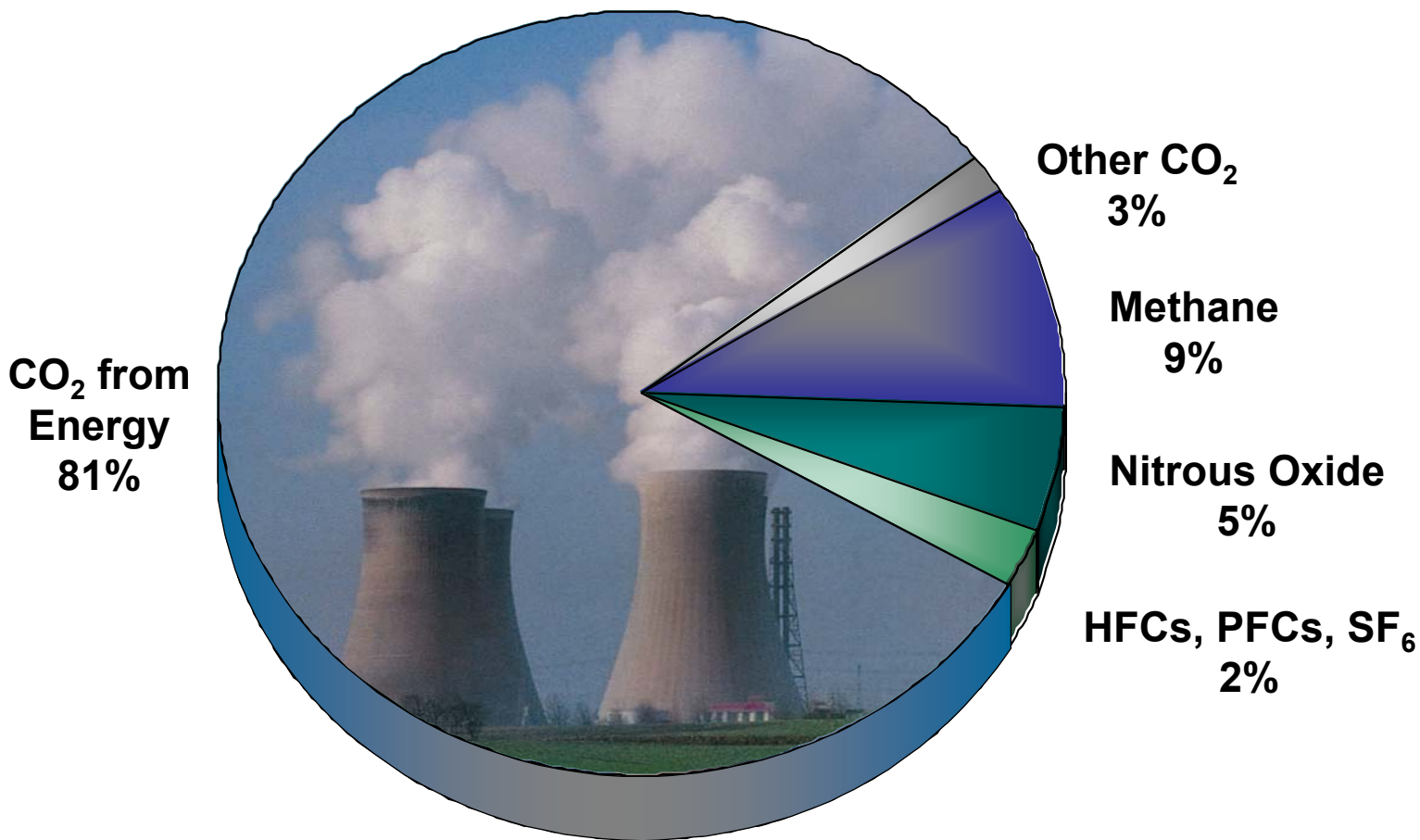
- Sustain economic growth
- Reduce GHG intensity by 18% in next 10 years
- Reevaluate science & path in 2012



White House photo: Paul Morse

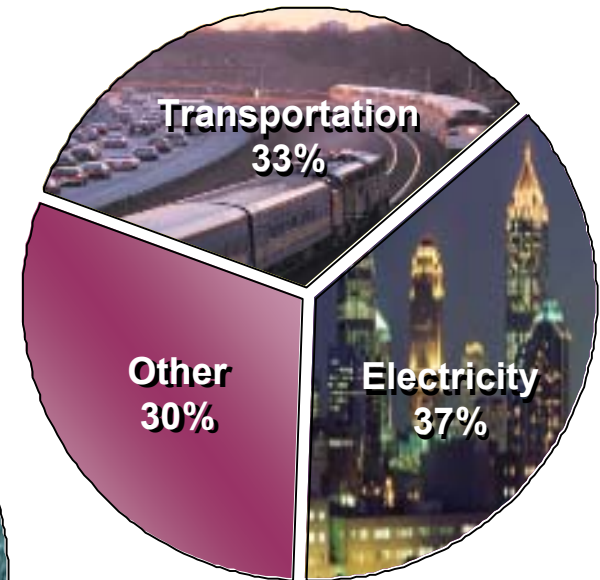
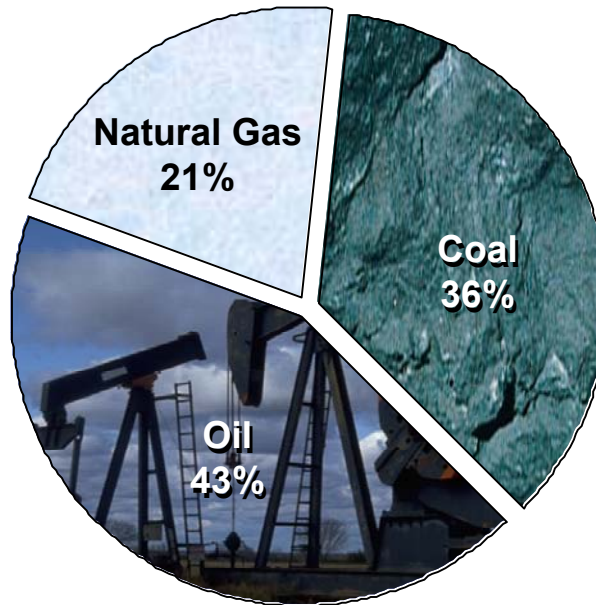
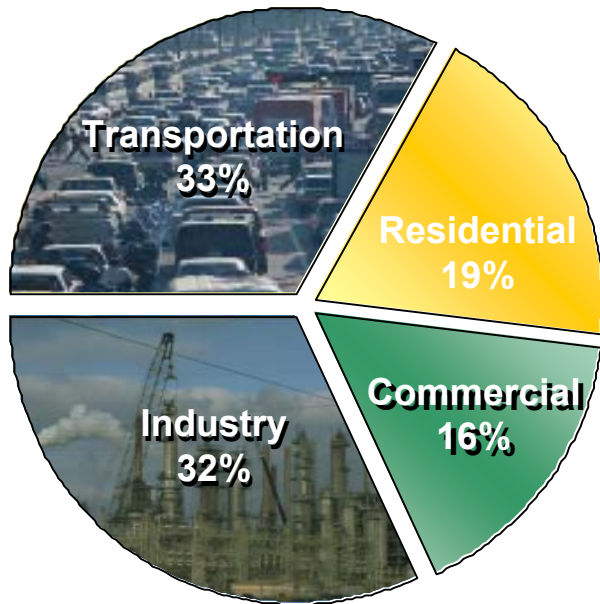
Roadmap Focuses on CO₂ & CH₄

United States Greenhouse Gas Emissions (Equivalent Global Warming Basis)



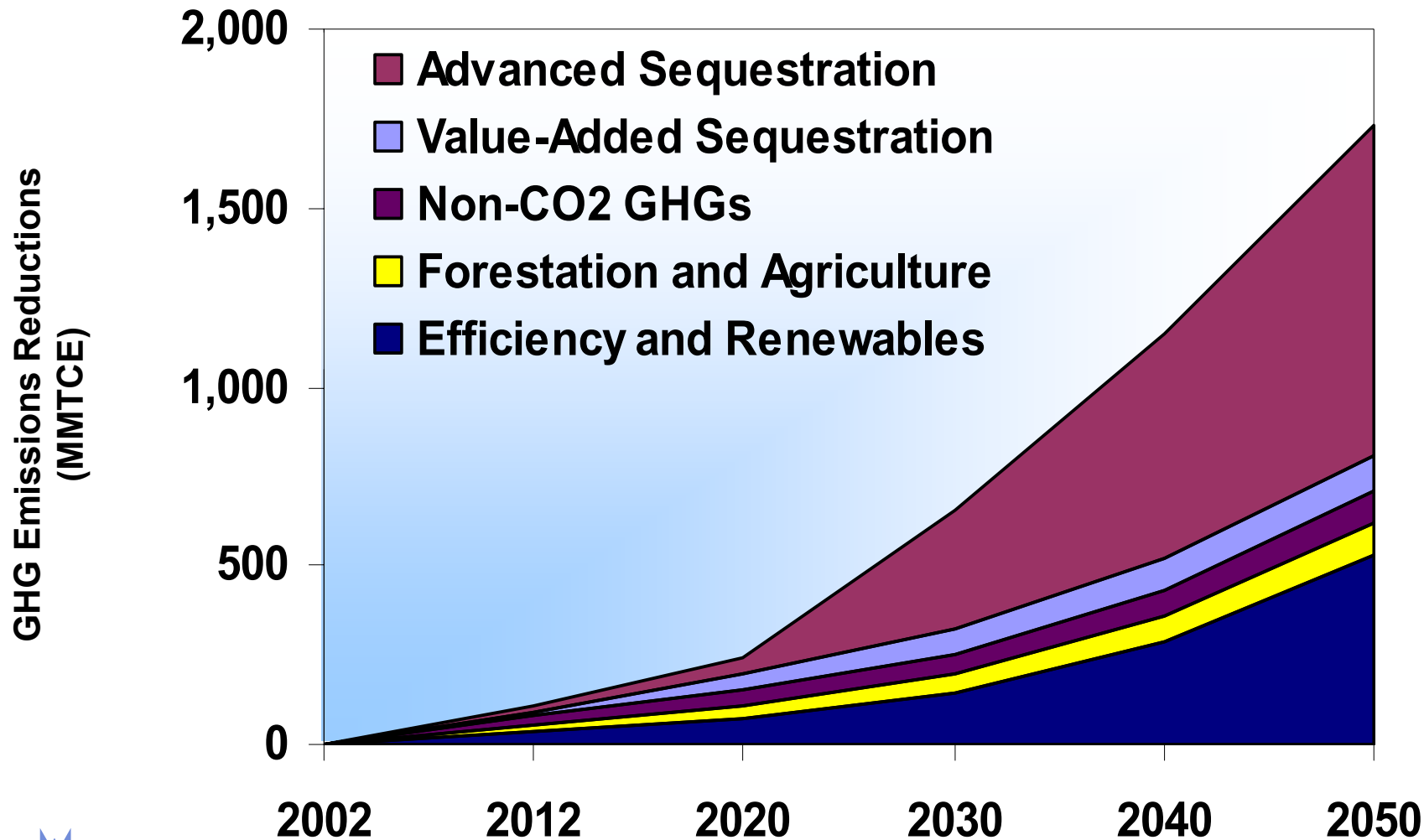
Roadmap Focuses on Coal & Electricity

United States Carbon Dioxide Emissions
(By Source & Sector)



Sequestration = Stabilization

Plausible Scenario to Stop GHG Emissions Growth



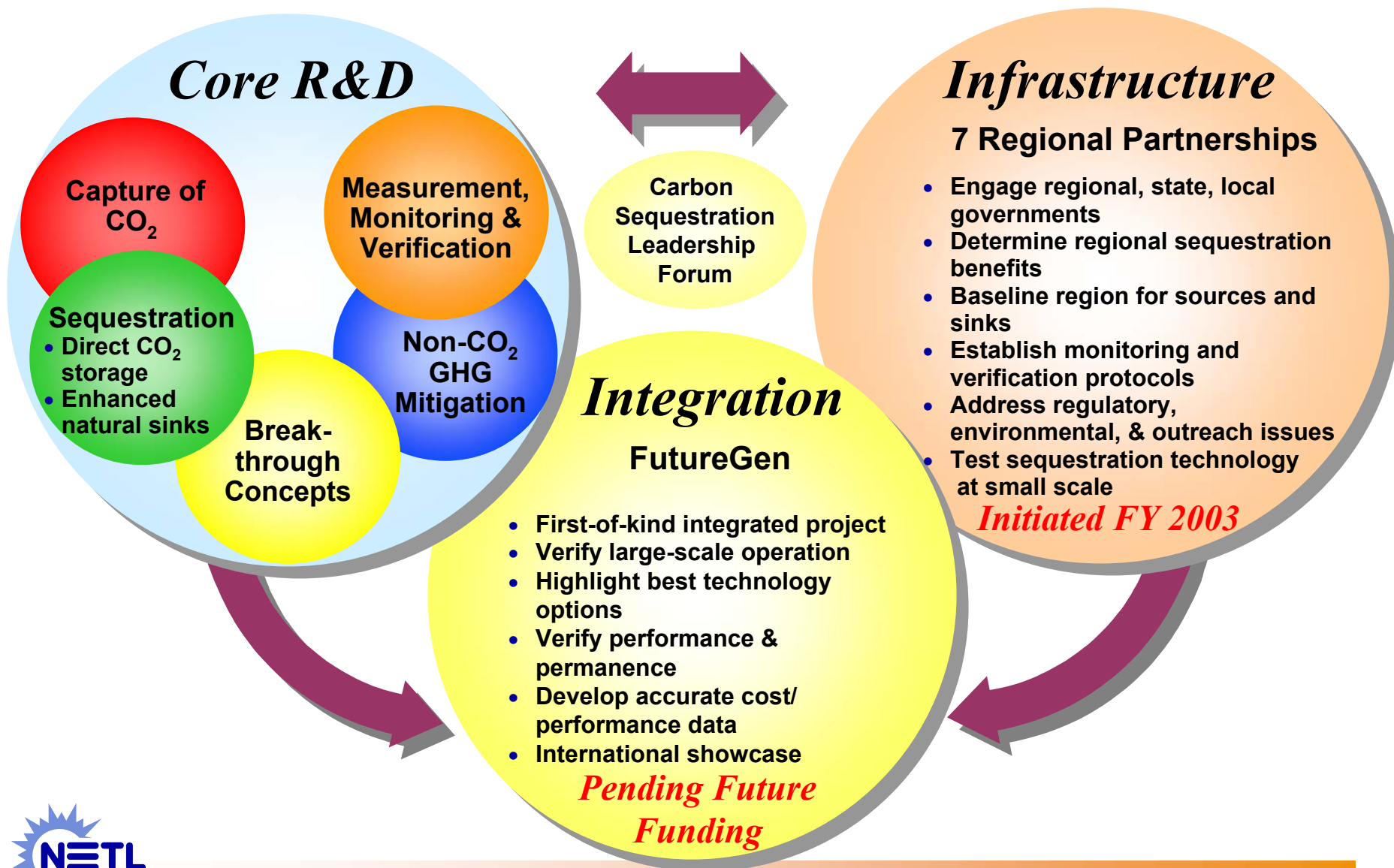
EIA Annual Energy Outlook 2002; EPA special studies;
DOE/FE/NETL Sequestration Benefits Model



DOE Carbon Sequestration Program



Carbon Sequestration Program Structure



Sequestration Program Goals

Develop Technology Options for GHG Management That...

- Are safe and environmentally acceptable
- Result in
 - < 10% increase in cost of energy services (< \$10/tonne CO₂ avoided) for capture, transport, & storage
 - With Measurement, Monitoring & Verification protocols for assurance of permanent storage
- Global Climate Change Initiative
 - Contribute to reducing carbon intensity by 18% by 2012
 - Provide portfolio of commercially ready technologies for 2012 assessment

Cost Performance Goals

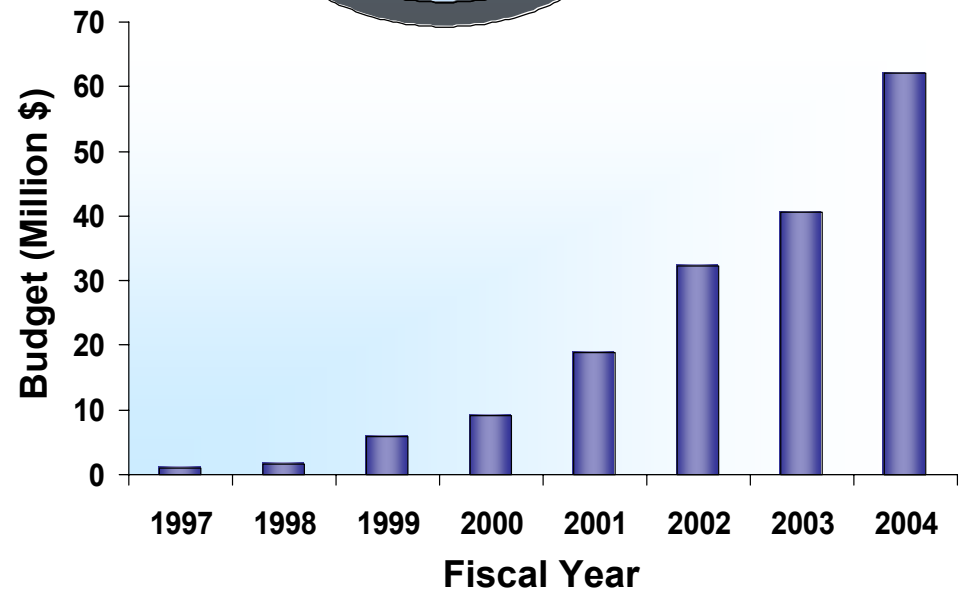
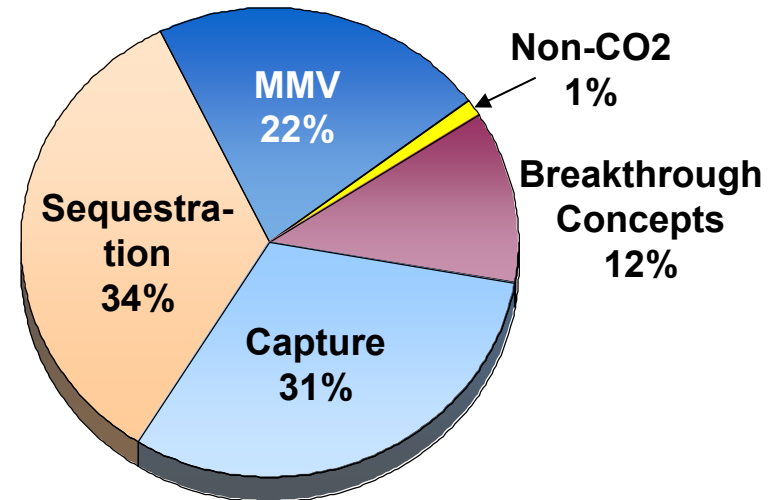
Year	COE Penalty IGCC Plants (% Increase)	COE Penalty PC Plants (% Increase)
2002	30	80
2007	20	45
2012	10	20
2015	<10	10
2018*	0	0

*Cost/Energy offset from sequestering CO₂ with criteria pollutants NO_x, SO_x, H₂S (gasification)



Portfolio Overview

- **Diverse research portfolio**
 - 64 external projects
 - 18 focus area projects
 - BP & IEA consortia
- **Strong industry support**
 - ~ 37% cost share
- **Total portfolio ~ \$140M**

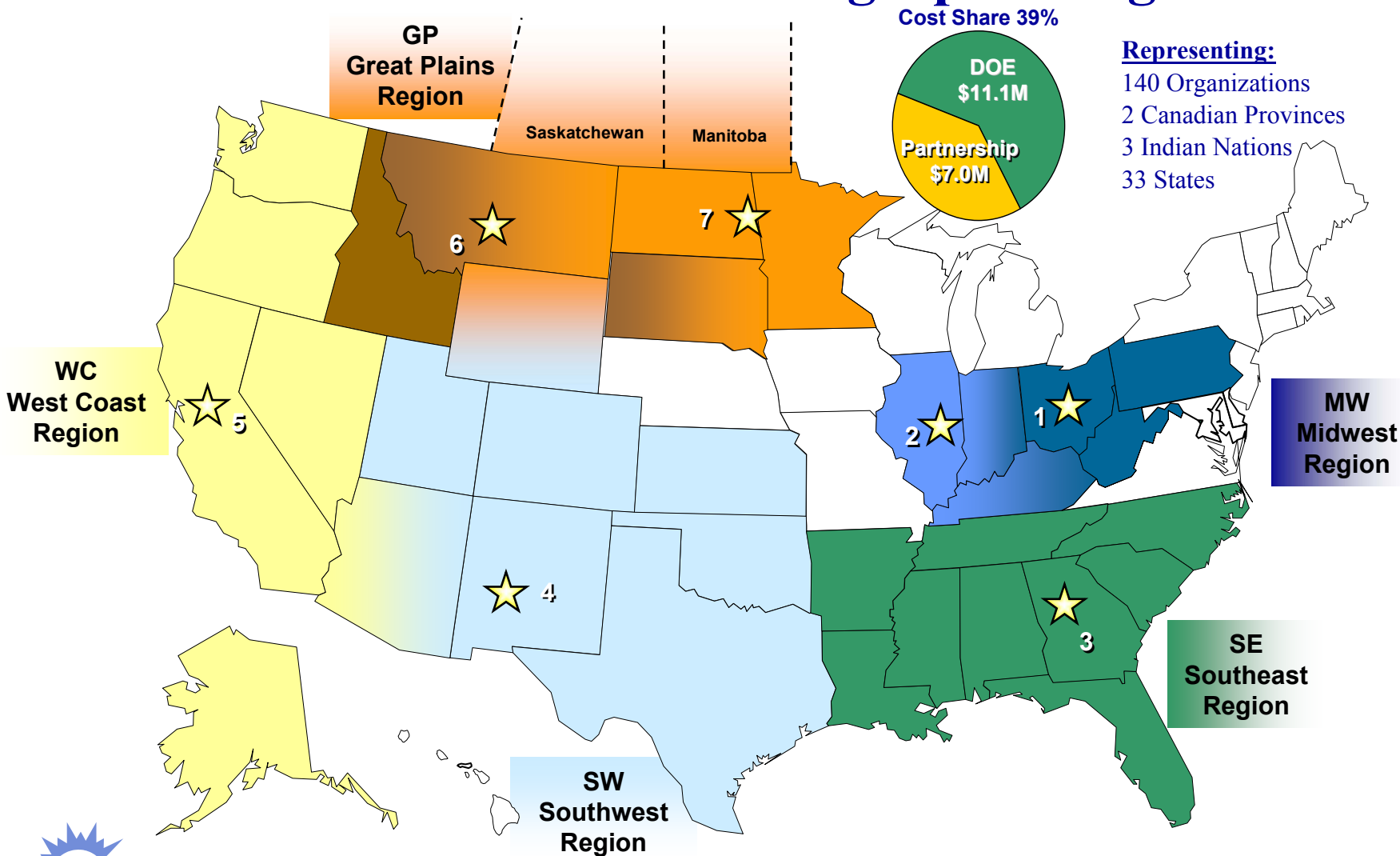


Enter....

Regional Carbon Sequestration Partnerships



Seven Regional Carbon Sequestration Partnerships Established in Five Geographic Regions



Two-Phased Approach

Phase I (Planning)

- 7 Projects
- 18-24 months
- ~\$1.5 million per project
- Overall ~ 40% cost share
- 2 exceed 50% cost share



Phase II (Proof-of-Concepts)

- 7 years
- ~ \$5 million per year/project
- minimum 20% cost share
- 4 to 5 Regions

Regional Carbon Sequestration Partnerships

Developing Infrastructure for Wide Scale Deployment

- **Baseline region for sources and sinks**
- **Address regulatory, environmental, outreach issues**
- **Establish monitoring and verification protocols**
- **Validating sequestration technology & infrastructure**
 - Phase 1 - design
 - Phase 2 - testing
- **Determine benefits of sequestration to region**

These partnerships - 4 to 10 across the country, each made up of private industry, universities, and state and local governments - will become the centerpiece of our sequestration program. They will help us determine the technologies, regulations, and infrastructure that are best suited for specific regions of the country.

Energy Secretary Spencer Abraham
November 21, 2002

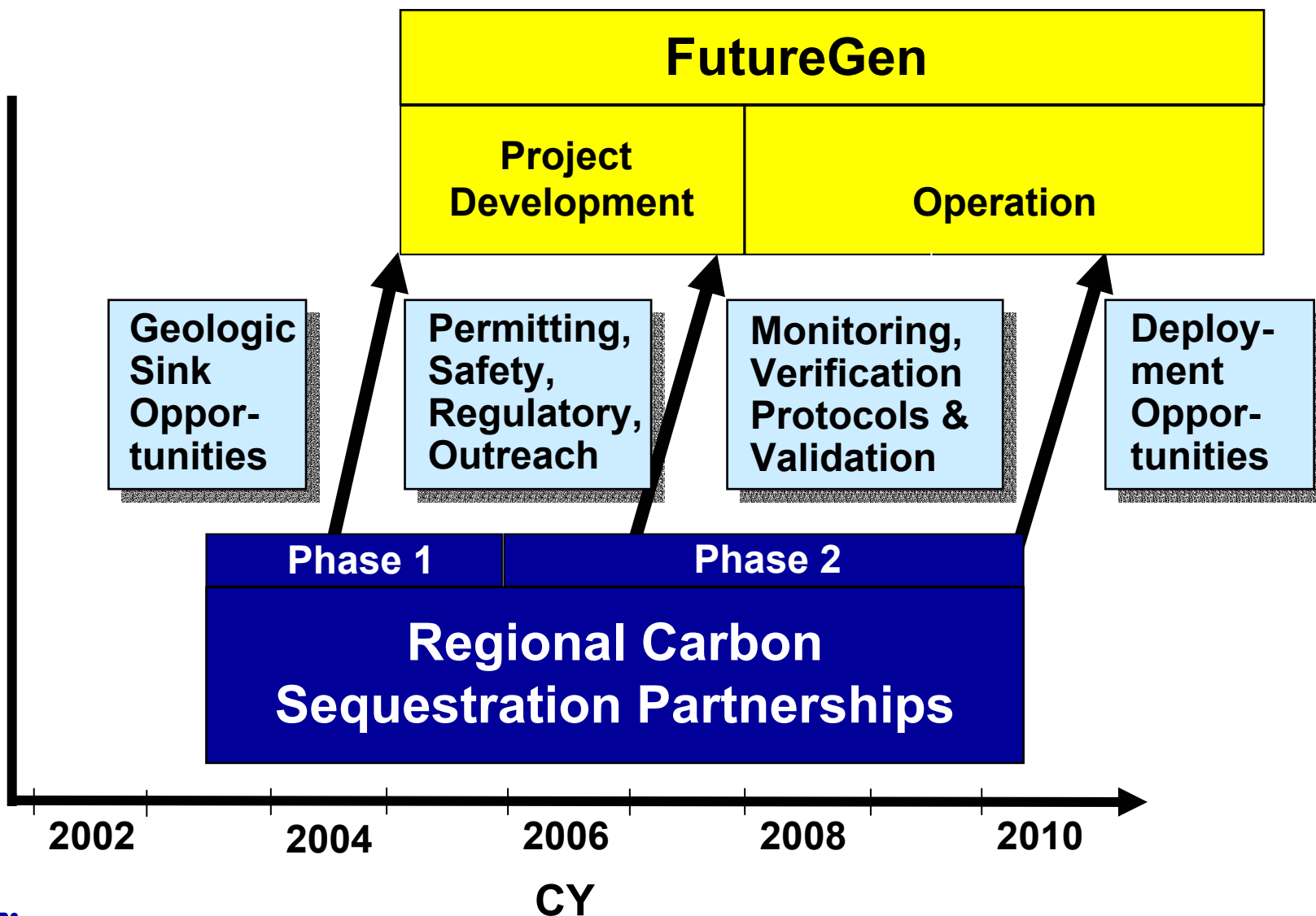


Phase II Approach

- **Not a technology development program!**
- **Establish wide-scale deployment opportunities**
- **Establish and implement Measurement, Monitoring & Verification protocols**
- **Establish and implement accounting & regulatory approaches**
- **Implement outreach mechanisms**
- **Perform proof-of-concept field tests for technology & infrastructure concepts**



Critical Synergy With Carbon Sequestration Program



- **Regional Carbon Sequestration Atlases**

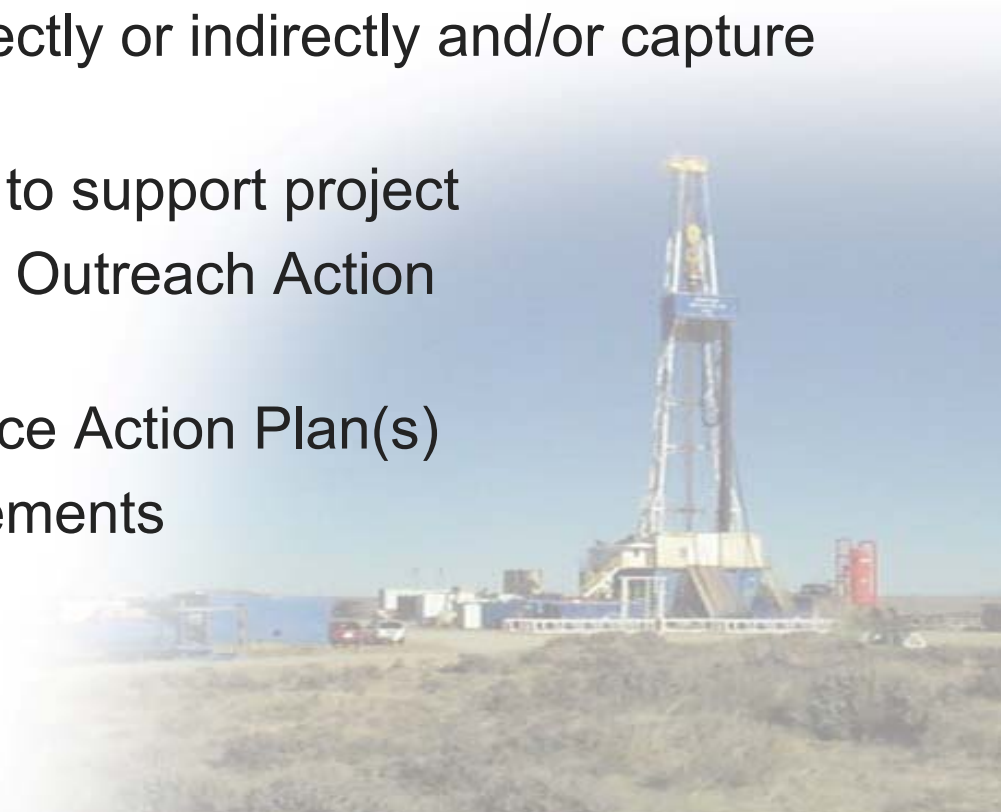
-
- The screenshot displays the ArchGIS Viewer application running in a web browser. The main map area shows a detailed view of Ohio, with state boundaries and major roads visible. The map is overlaid with various colored regions representing different types of CO2 sources. A legend on the left side of the map provides a key for these sources, categorized by state and type. The top of the window shows the browser interface with the URL 'http://heubino.lgs.ku.edu/website/MEDCARB_NEW/viewer.htm'. The bottom status bar provides map coordinates and a scale bar.
- Legend:**
- CO2 Sources**
 - OH - CO2 Sources**
 - Gas
 - Oil
 - Storage
 - IN - Oil and Gas Fields**
 - Gas
 - Oil
 - Storage
 - IL - Oil and Gas Fields**
 - Gas
 - Oil
 - Storage
 - KY - Petroleum Fields**
 - Non-associated gas
 - Oil
 - Oil with associated gas
 - Oil with non-associated gas
 - Oil with associated and non-associated gas
- Map Coordinates:** 1021480 meters (East), 4398821 meters (North) [UTM Zone 16 NAD83]
- Scale:** 0 to 90 miles



Regional Partnerships Outcomes

- **Regional Project Implementation Plan(s)**

- Identify the most promising technologies/ approaches to sequester carbon directly or indirectly and/or capture carbon in the region
- Cost/benefit analysis to support project
- Public Education and Outreach Action Plan(s)
- Regulatory Compliance Action Plan(s)
- MMV Project Requirements



Regional Partnerships Outcomes

- **Action Plan for Regulatory Compliance**
 - Existing or future regulations that will impact sequestration program
 - Identify risk assessment and liability issues
 - Timeline for permitting regional projects
 - MMV and Reporting Requirements
 - Responsibilities



Regional Partnerships Outcomes

- **Action Plan for Public Outreach and Education**
 - Methods to engage the public
 - Tools to educate stakeholders
 - Regulatory requirements for public outreach



Regional Partnerships Coordination

- **Meetings**

- Annual Partnership Review Meetings (November)
- Participate in May 2004 and 2005 National Carbon Sequestration Conferences, Alexandria, VA
- Possible quarterly focus group teleconferences

- **Resources**

- Updates to NETL Webpage with presentations, news releases, partnership contacts, reports, etc.
- Project Managers
- Other partnerships



Leveraging Opportunities Must Be Pursued!

- **DOE is responsible for provided U.S. wide uniformity & consistency where appropriate**
- **DOE plans to leverage existing activities as appropriate**
 - MidCarb & MIT GIS approaches
 - Keystone Center outreach activities
 - IOGCC regulatory guidelines
 - Others are being identified
- **DOE would support these activities in addition to the Partnerships**



NETL Management Team

Scott Klara, Carbon Sequestration Technology Manager

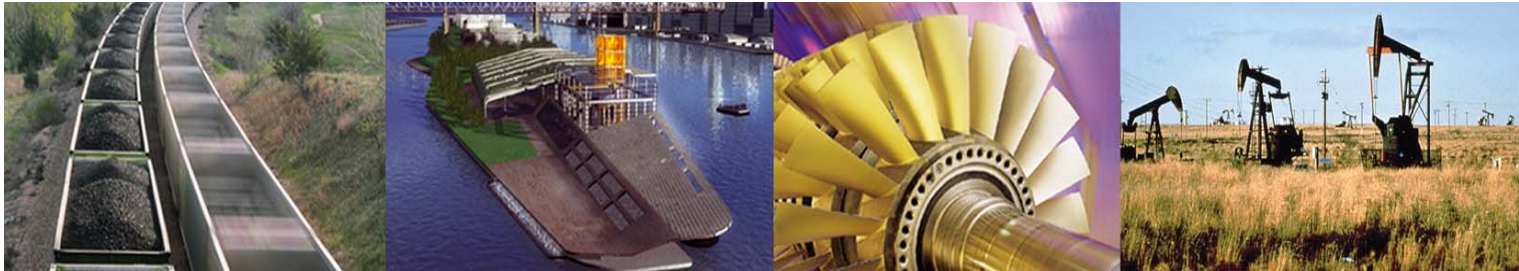
Richard Rogus, Contracting Officer

Kanwal Mahajan, Division Director, Environmental Projects

Regional Partnership Name	Lead Organization	DOE Contract Specialist	DOE Project Manager
Southeast Regional Carbon Sequestration Partnership	Southern States Energy Board	Mary Beth Pearce	Karen Cohen
Midwest Regional Carbon Sequestration Partnership	Battelle Memorial Institute	Donna Jaskolka	Charlie Byrer
An Assessment of Geological Carbon Sequestration Options in the Illinois Basin	Illinois State Geological Survey	Donna Jaskolka	Charlie Byrer
Plains CO2 Reduction Partnership	Energy & Environmental Research Center	Juliana Murray	John Litynski
Northern Rockies and Great Plains Regional Carbon Sequestration Partnership	Montana State University	Angela Delmastro	John Litynski
Southwest Regional Partnership for Carbon Sequestration	New Mexico Institute of Mining and Technology	Mary Beth Pearce	David Hyman
West Coast Regional Carbon Sequestration Partnership	State of California, California Energy Commission	Angela Delmastro	David Hyman



Questions ?



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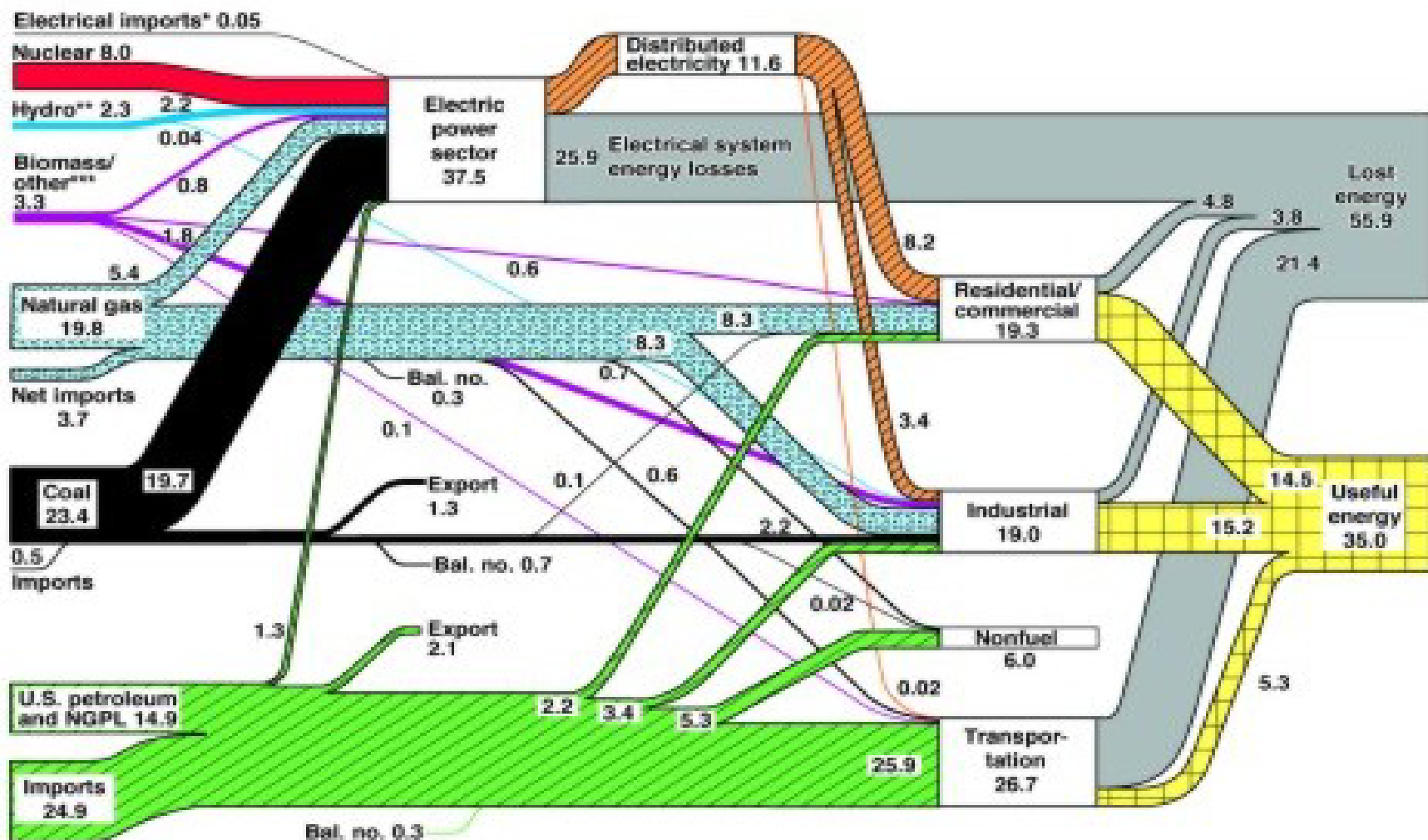


West Coast Regional Carbon Sequestration Partnership

Terry Surles
California Energy Commission (CEC)

U.S. Energy Flow Trends – 2001

Net Primary Resource Consumption ~97 Quads



Source: Production and end-use data from Energy Information Administration, Annual Energy Review 2001

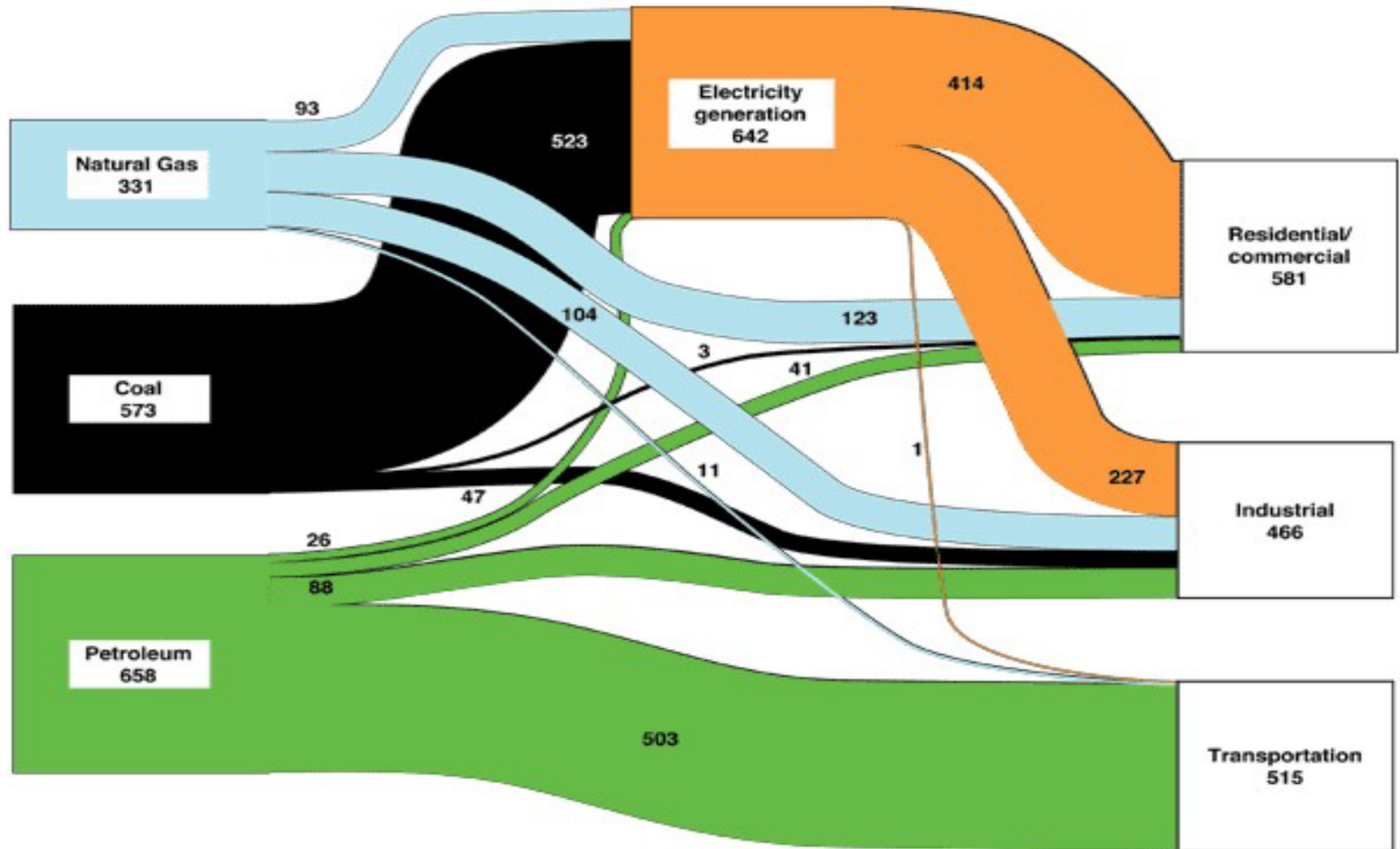
*Net fossil-fuel electrical imports

**Includes 0.2 quads of imported hydro

***Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.

Lawrence Livermore
National Laboratory
<http://eod.lbnl.gov/flow>

US 2000 carbon emissions from energy consumption — 1547* MtC

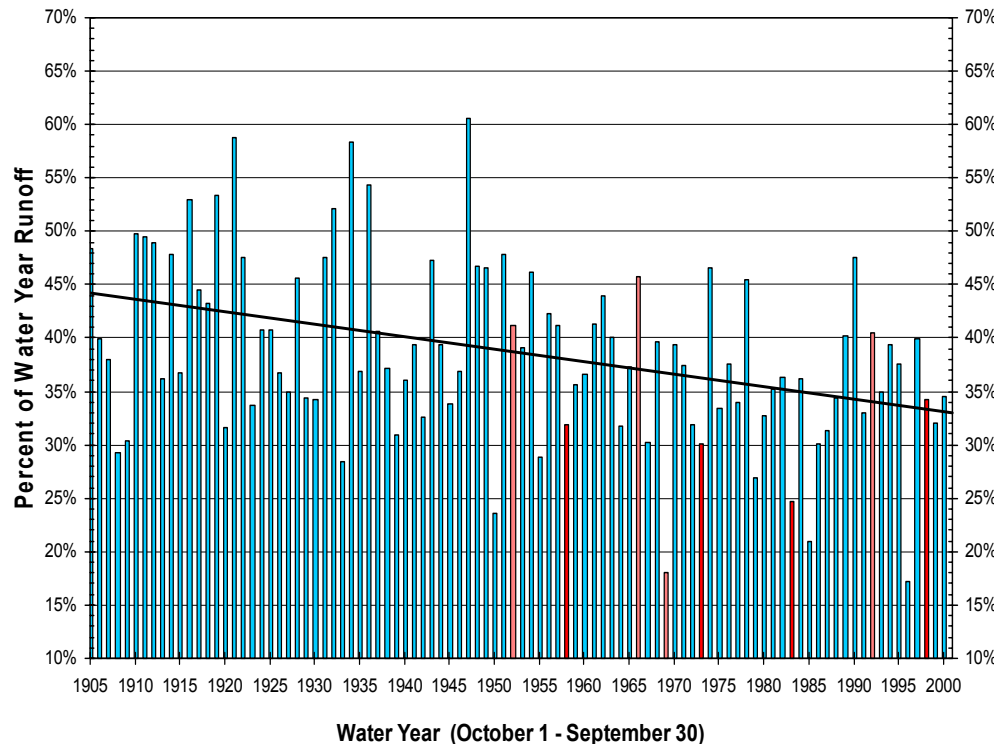


Source: Energy Information Administration
 *Includes adjustments of 14 million metric tons of carbon from U.S. territories, less 28 MtC from bunker fuels

Lawrence Livermore National Laboratory, April 2002
<http://en-env.llnl.gov/flow/>



Our Principal Reservoir - The Sierra Snow Pack - Is Shrinking



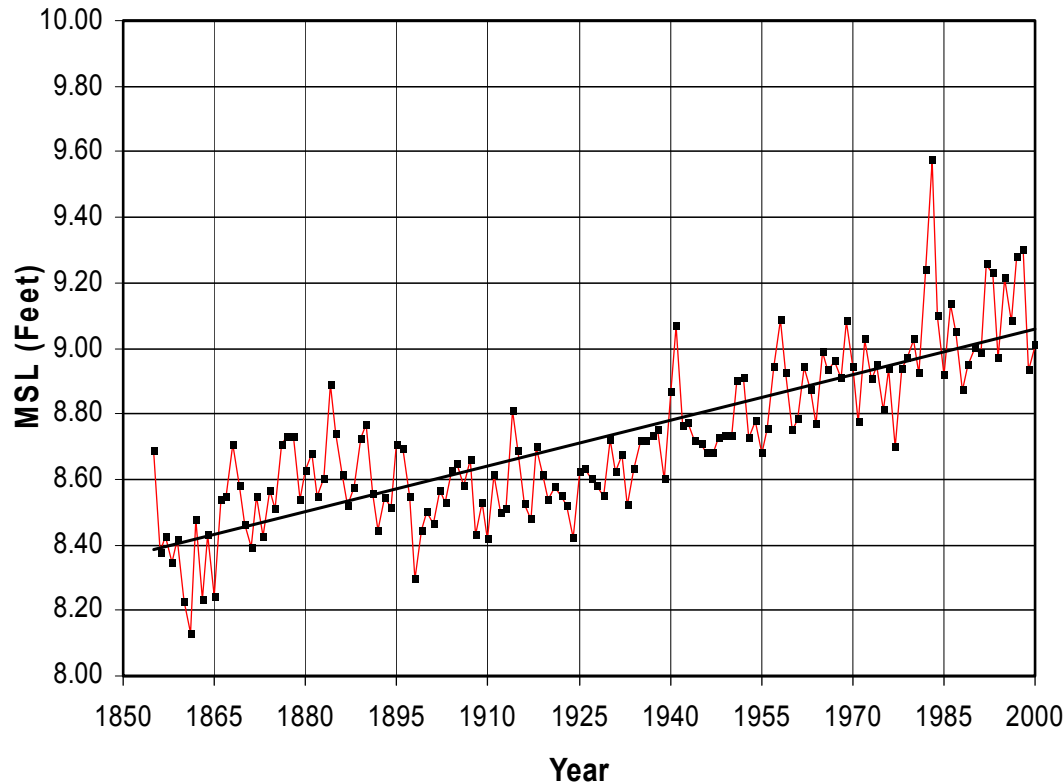
*Sacramento River Runoff (1906-2001)
April to July as a Percent of Total Runoff*

Warmer Winters Have:

- * **Reduced snow pack**
- * **Earlier snow melt**
- * **Decreased Spring runoff by 10%**



Sea Level Is Rising Along The West Coast



- ★ Rise of 7" in 150 years
- ★ IPCC projects 4-35" sea level rise by 2100

***Golden Gate Gauge Yearly Mean Sea Level
(1855-2000)***

Source: California Protection Agency, Environmental Protection Indicators for California, 2001



The Region Forms a Coherent Study Unit

- ★ **Significant CO₂ source - over 11% of US anthropogenic emissions**
- ★ **Commonality in terrestrial sinks in WA, OR, and Northern CA**
- ★ **Commonality and large potential capacity in geological sinks in CA, NV, and AZ**
- ★ **Significant potential for offsetting costs with EOR and EGR in California and Alaska North Slope**





Partnership Has Been Designed to

Advance Practical Applications of Carbon Sequestration

- ★ Capture, transport and geological storage options
- ★ Terrestrial sequestration opportunities
- ★ Regulatory analysis and permitting
- ★ Monitoring and verification
- ★ Economic and environmental efficacy
- ★ Public outreach and education
- ★ Information on regional source/sink relationships



A Strong Multi-Sectoral Team Has Been Assembled for This Program

- ★ **Policy and Coordination** (Western Governor's Association)
- ★ **State Resource Management, Environmental Protection, and Regulation** (CA Dept. of Forestry and Fire Protection, CA Dept. of Oil, Gas and Geothermal Resources, CA Geologic Survey, CAL EPA, OR Dept. of Forestry, Nevada Bureau of Mines and Geology, WA Dept. of Natural Resources)
- ★ **Oil and Gas Companies** (AERA, BP, Chevron Texaco, ConocoPhillips, Occidental Petroleum, Shell)



A Strong Multi-Sectoral Team Has Been Assembled for This Program

- ★ **NGO's** (Pacific Forest Trust, Natural Resources Defense Council)
- ★ **Utilities** (Pacific Corp., Salt River Project, Sierra Pacific Resources, TransAlta)
- ★ **National Lab and Research Institutions** (Electricity Innovation Institute, Kearney Foundation, LBNL, LLNL, MIT, Stanford-GCEP, Winrock, U of Alaska)
- ★ **Engineering Companies** (Advanced Resources International, Clean Energy Systems, KinderMorgan, Nexant, SFA Pacific, Terralog)
- ★ **Public Outreach/Education** (Cal State Bakersfield, Cal Poly, SF Dept. of Environment, Science Strategies, Western State Petroleum Association)



Phase I is Organized into Four Task Areas for Achieving Our Goal



- ★ **Regional characterization and data integration**

- ◆ Point source information
- ◆ Terrestrial data and characteristics
- ◆ Geologic data and characteristics
- ◆ Transportation information

- ★ **Technology deployment**

- ◆ Environmental regulations, impacts
- ◆ Life cycle analyses
- ◆ Geological risk assessment
- ◆ Monitoring and verification

- ★ **Public outreach**

- ◆ Action plan for outreach
- ◆ Education and training
- ◆ Sensitivity to unique stakeholder needs

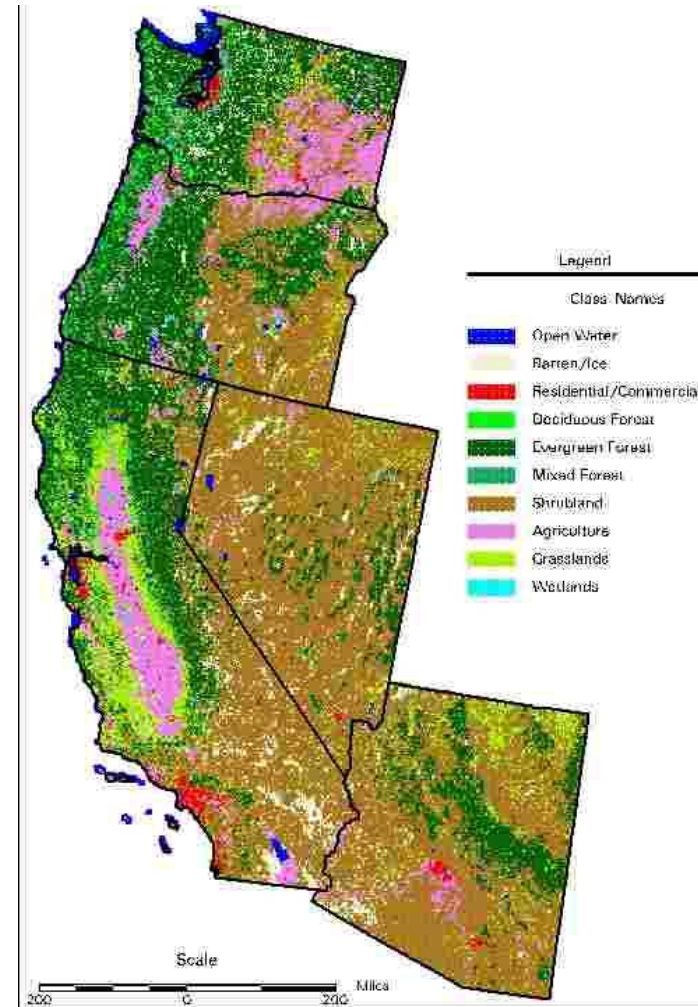
- ★ **Options and opportunities**





Regional Characterization: Data Collection is Already Underway

- ★ Terrestrial data includes land use, land cover, hydrology, soil maps, crop yields, land ownership, etc.
- ★ Point source data for power plants and major industrial sources; location, amount, processes
- ★ Transportation data with focus on pipelines, including right-of-ways and topography
- ★ Geologic data includes location, depth, formation properties, etc.

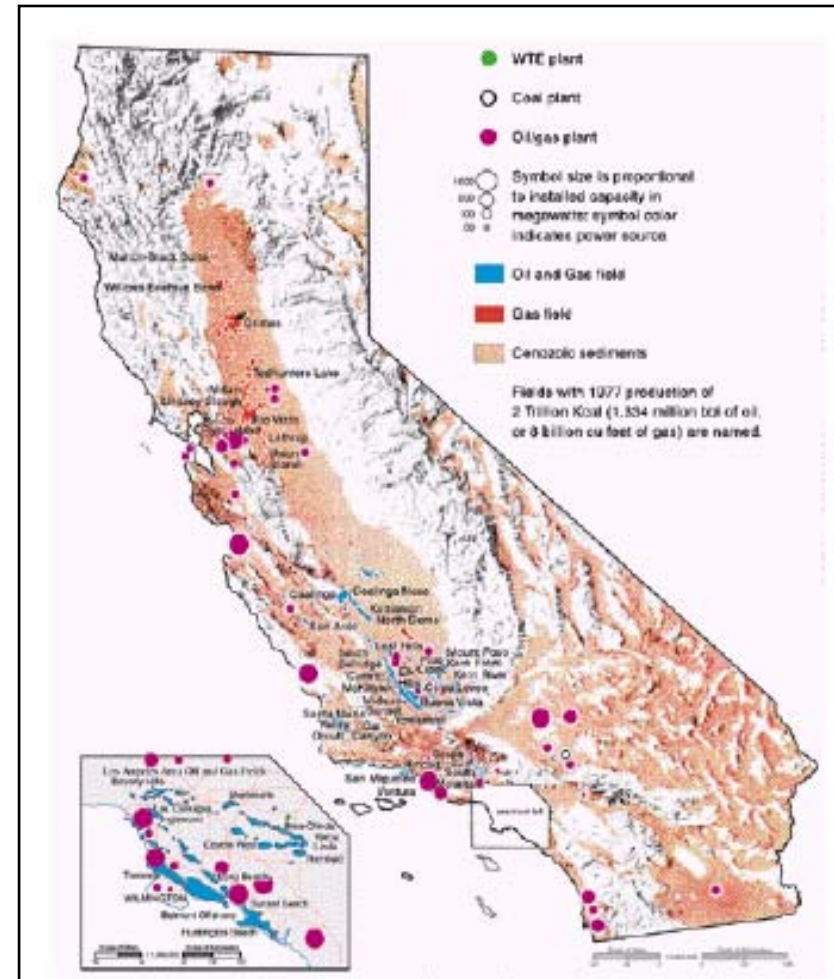




Regional Characterization: Data

Integration Activities Are Already Underway

- ★ Winrock will develop two point terrestrial baselines for WA, OR, AZ, and CA
- ★ Complementary effort by Kearney Foundation on soil carbon storage in California
- ★ Consolidated GIS-based geologic sequestration database to be developed
 - ◆ Source, transport, and site data
 - ◆ Cooperative effort with WGA, Utah AGRC, MIT, and CA Geologic Survey



Power plants and oil/gas fields in California



Technology Deployment Must Consider Life Cycles

- ★ Life cycle analysis of impact of CO₂ capture, transport and storage options
 - ◆ Overall economics
 - ◆ Other emissions
 - ◆ Policy considerations

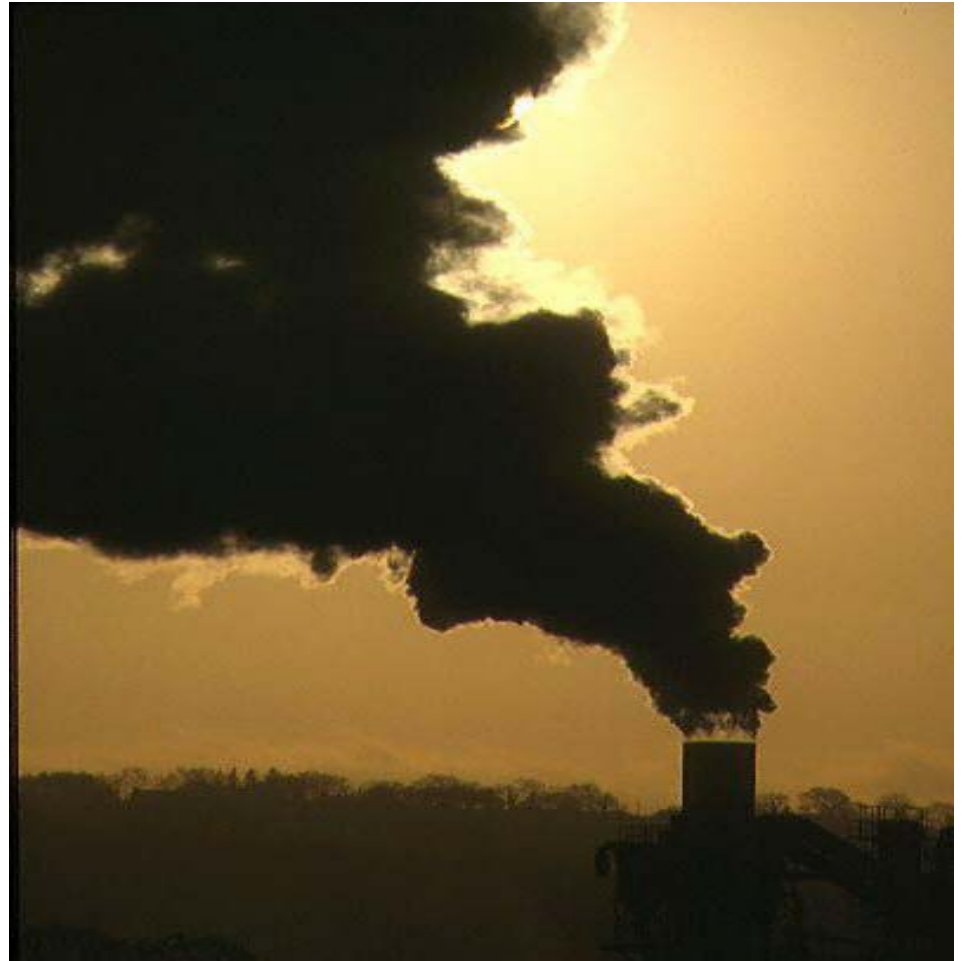




Technology Deployment Covers A Number of Regulatory Issues



- ★ Develop an action plan to address environmental efficacy and regulations; focus on strategy for pilot projects and larger-scale deployments
- ★ Compile and assess regulations and permits; current and future





Technology Deployment Issues: Develop Risk Assessment Framework for Geologic Sequestration



- ★ Builds on previous work for the Carbon Capture Project and others
- ★ Develop features, events and physical processes for failure analysis
- ★ Quantify failure probability and consequence





Technology Deployment Issues: Also Builds on Previous CCP Work

- ★ This allows a considerable head start for planned efforts
- ★ Utilize potential pilot sites for stimulation
- ★ Perform simulations to assess monitoring technique sensitivities





Public Outreach Will Be A Critical Component and Serve to Inform Public Policy



- ★ Create Partnership web site
- ★ Use existing channels, e.g.. State forestry depts.
- ★ Develop University and K-12 curricula; work with WGA
- ★ Hold stakeholders' meeting
- ★ Advice from NGOs, other stakeholders
- ★ Prepare action plan



SF Environment



NATURAL RESOURCES DEFENSE COUNCIL



THE PACIFIC FOREST TRUST

Preserving Productive Forestlands



Identify Terrestrial Sequestration Options and Opportunities



- ★ **Prepare supply curves for major classes of regional land use and forest activities**
- ★ **Evaluate potential pilot projects**
 - ◆ Increasing mass of large trees and dead wood
 - ◆ Reducing large fires
 - ◆ Reforesting riparian zones
 - ◆ Foresting marginal lands
 - ◆ Changing commercial practices to increase carbon stocks
- ★ **Winrock will coordinate with Arizona Dept. of Forestry, California Dept. of Forestry and Fire Protection, Oregon Dept. of Forestry, Washington State Dept. of Natural Resources, Pacific Forest Trust**

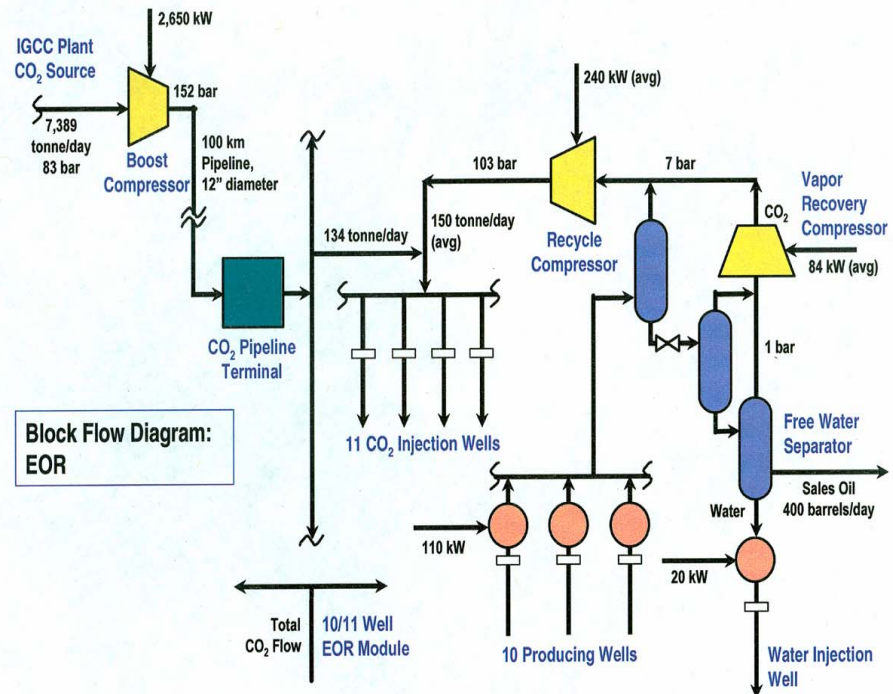




Identify Geologic Sequestration Options and Opportunities



- ★ **Perform economic, transportation, geologic screening and other analyses on GIS database to obtain best geologic options**
 - ◆ Consider about five transport - storage options for each source
- ★ **E2I/EPRI to lead team**
 - ◆ MIT (scenario analyses on GIS data)
 - ◆ SFA Pacific (capture economics)
 - ◆ ARI (EOR, EGR engineering and economics)
 - ◆ LBNL (geologic screening)
 - ◆ Coordinate input from utilities, oil companies, others





Field Pilot Demonstrations Will Emphasize All Program Components



- * **Action plan will ensure proper evaluation of all possible activities within region and provide focus**

- ◆ Technology demonstration
- ◆ Monitoring and verification
- ◆ Risk assessment
- ◆ Regulatory definitions
- ◆ Public outreach and education





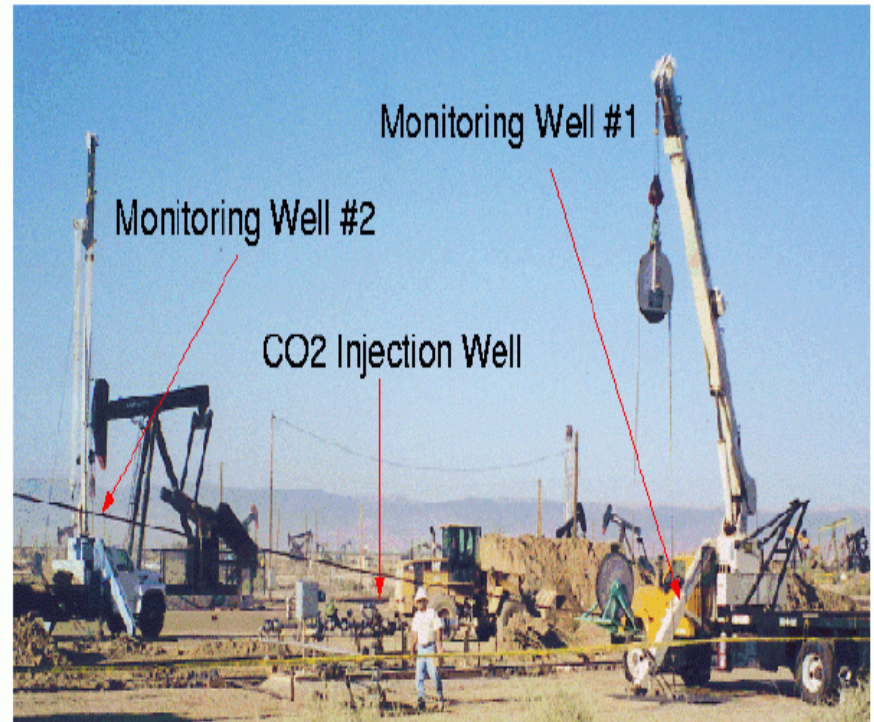
Action Plan for Geologic Field Pilot Demonstrations



★ EOR projects are best opportunities:

- ◆ Elk Hills (Occidental)
- ◆ Ventura (Shell/Aera)
- ◆ Huntington Beach (Shell/Aera)
- ◆ Prudhoe Bay (BP)

Chevron Lost Hills CO2 Injection Monitoring Field Site





Action Plan for Terrestrial Pilot Demonstrations Will Target One Each In:

- ★ **Oregon**
- ★ **Washington**
- ★ **Arizona**
- ★ **California**





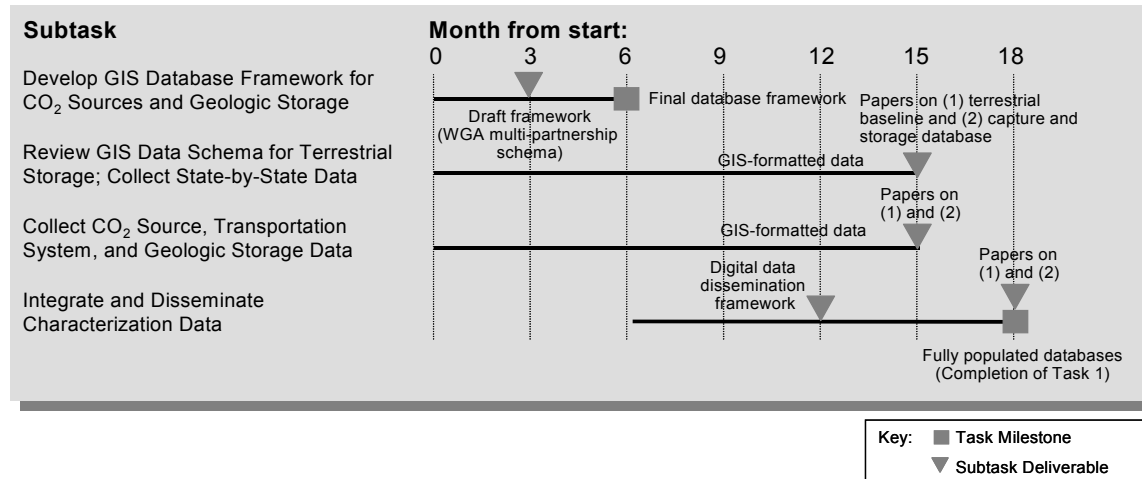
Phase I: Projected Deliverables

- ★ Consolidated database of information on carbon sequestration, including sources, terrestrial and geologic sinks, and infrastructure
- ★ Compilation and assessment of regulations
- ★ Geologic risk assessment framework
- ★ Assessment of impacts on other emissions
- ★ Protocols for monitoring and verification
- ★ Materials for a public outreach program
- ★ Framework for comparison and selection of sequestration options, including economics (supply curves), capture technology, risk, etc.
- ★ Selection and plans for demonstrations in Phase II

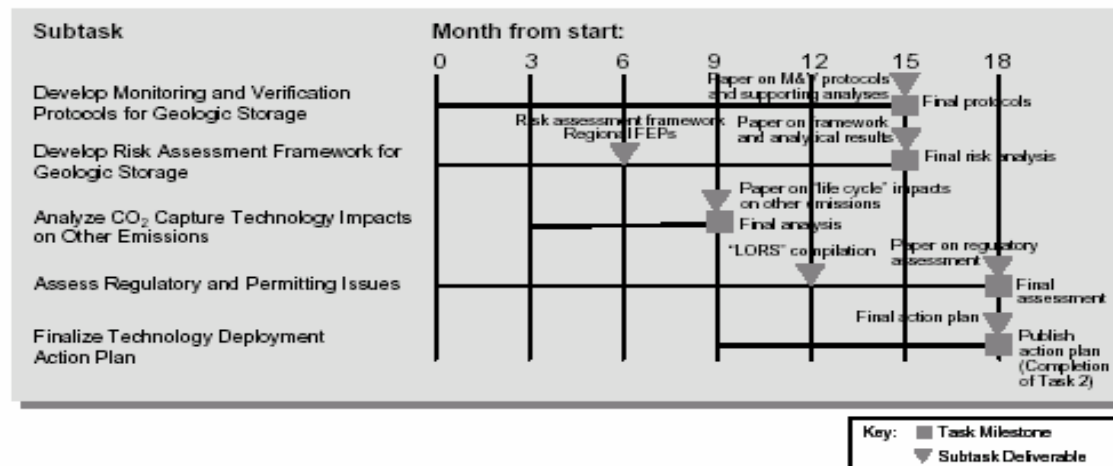


Task Schedules

Schedule, Milestones, and Deliverables for Task #1



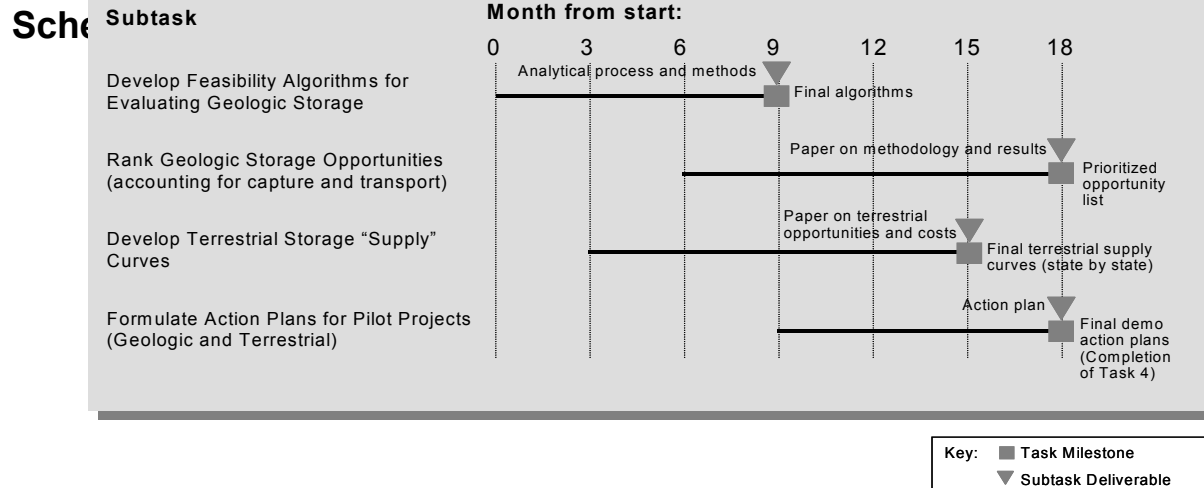
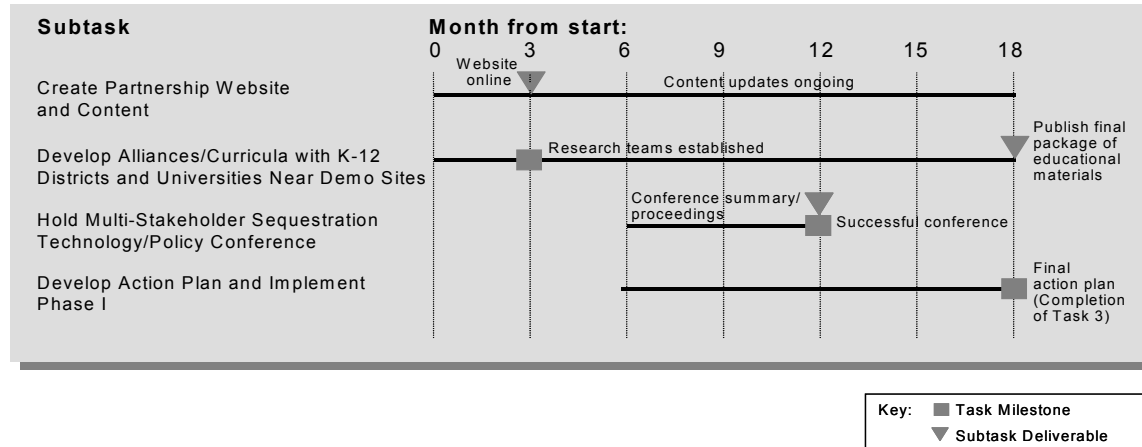
Schedule, Milestones, and Deliverables for Task #2





Task Schedules Cont'd

Schedule, Milestones, and Deliverables for Task #3





West Coast Regional Partnership Will Be A Springboard for Deployment of Technologies and Practices



- ★ Determine suite of technologies best suited for region based on sources, sinks, and infrastructure
- ★ Address regulatory issues and infrastructure needs for technology deployment
- ★ Address public concerns proactively and develop educational materials to enhance public acceptance of technologies
- ★ Identify least cost options associated with sequestration alternatives
- ★ Evaluate environmental and public health risks and develop mitigation strategies



Our Commitment to the Team is Consistent With Explicit USDOE Goals

- ★ Development of regional source/sink information will have intrinsic value to many organizations
- ★ Work effectively with DOE and other regional partnerships to share information that enhances sequestration opportunities
- ★ Development of a robust action plan can effectively support possible Phase II pilots



A Number of West Coast Partnership Members Are Here to participate in the Breakout Groups

Session 1: Regulation

Kelly Birkinshaw - CEC

Session 2: Outreach

Martha Krebs - Science Strategies

Session 3: Capture & Separation

John Ruby - Nexant

Session 4: Geology

Larry Myer (Facilitator) - UCOP

Session 5: Terrestrial

John Kadyszewski - Winrock

Session 6: GIS/Database

Richard Rhudy - EPRI

Dennis Goreham - Utah AGRC

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Midwest Geological Sequestration Consortium

An Assessment of Geological Carbon Sequestration Options in the Illinois Basin

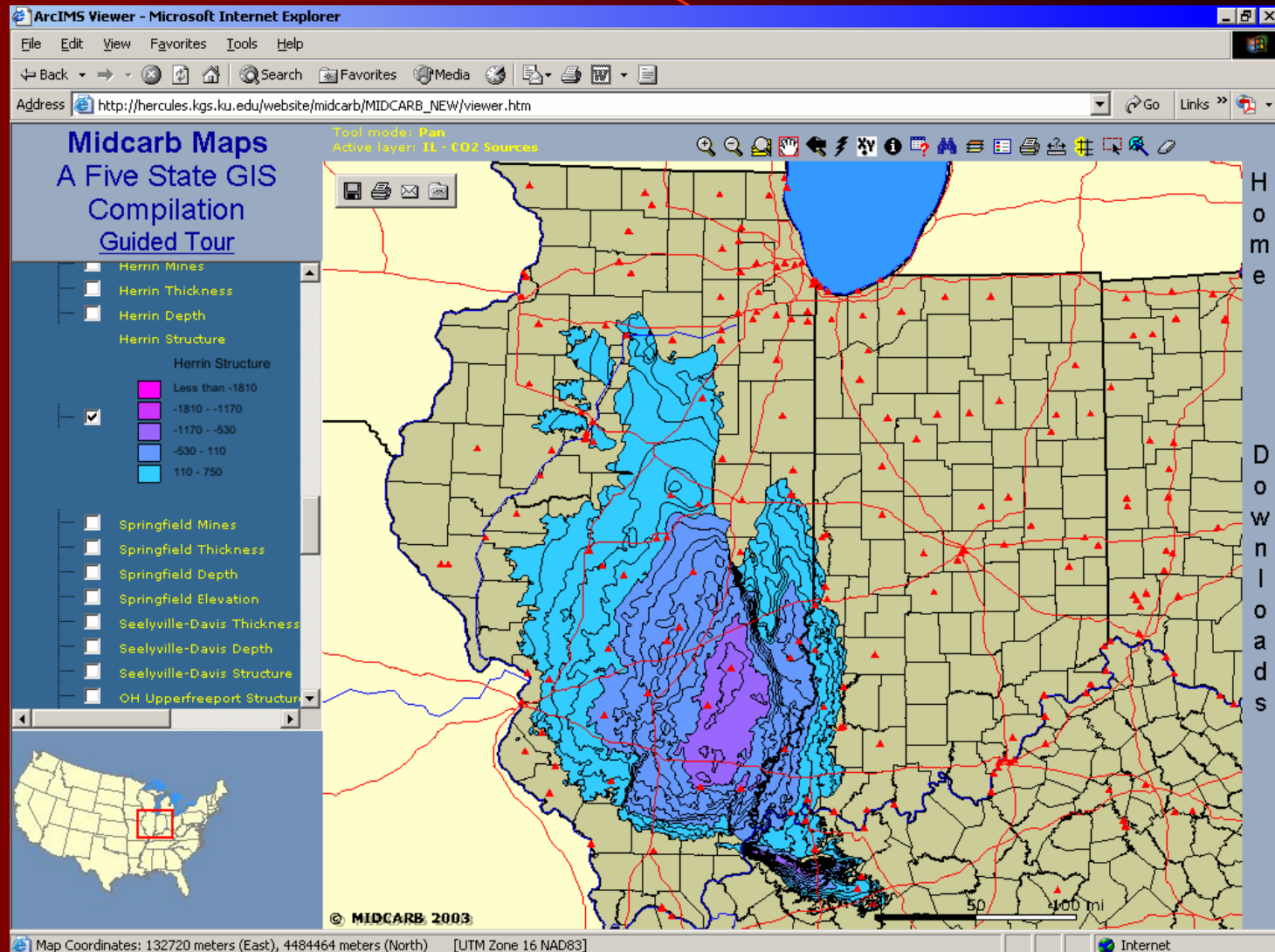
Robert J. Finley
Illinois State Geological Survey
and the MGSC Team

U.S. Department of Energy Kickoff Meeting
November 3, 2003

Partnership Focus

- Geological sequestration potential in the 60,000 sq mi area of the Illinois Basin of Illinois, western Indiana and western Kentucky
- Stationary sources emit in excess of 255 MMTCO₂ annually
- Emphasis on the three geological sinks: deep, uneconomic coal seams, mature oil reservoirs amenable to CO₂ EOR, and deep, saline reservoirs

Herrin Coal Structure Defines Illinois Basin



Midwest Geological Sequestration Consortium (MGSC) A DOE Regional Partnership

- Lead by Illinois State Geological Survey in collaboration with the Kentucky and Indiana Geological Surveys
- Survey staff make up six-member Technical Committee
- Subcontractors at BYU (geophysics), SIU (coal adsorption), D.J. Nyman & Assoc. (transportation [Houston]) and Dr. Dave Thomas (advisor [Chicago])

Midwest Geological Sequestration Consortium (cont'd)

- Three utility partners: Ameren, Louisville Gas and Electric, and Cinergy
- Three industry partners: Peabody Energy, Williams Bio-Energy, and American Air Liquide
- Trade groups and consortia: IL, IN, and KY Oil & Gas associations, ICGA, EPRI, IOGCC
- Illinois Office of Coal Development, DCEO
- Illinois Department of Natural Resources

Geologic Carbon Sequestration Options in the Illinois Basin: Project Structure

- Phase 1: Compile all available data and review CO₂ capture and transportation options
- Phase II: Assess the storage options, the heart of the project, looking at uneconomic coals, mature oil fields, and the deep, saline reservoirs
- Phase III: Integrate results from first two phases, determine how capture-transportation-storage would be linked, and generate plans for field tests

Geologic Carbon Sequestration Options in the Illinois Basin: Phase I

- 1: Compile and assess data (4 months)
- 2: Assess carbon capture options for the Illinois Basin (9 months)
- 3: Assess CO₂ transportation options in the Illinois Basin (9 months)
- Phase I completed in Year 1
- Topical report delivered and website operational

Geologic Carbon Sequestration Options in the Illinois Basin: Phase II

- 4: Assess coalbed sinks and methane production options (13 months)
- 5: Assess oil reservoir sinks and oil recovery options (15 months)
- 6: Assess deep saline reservoirs sinks (13 months)
- Tasks extend 4-5 months into Year Two

Geologic Carbon Sequestration Options in the Illinois Basin: Phase III

- 7: Integrate storage options to linked capture-transportation pathways (4 months)
- 8: Assess environmental-regulatory framework for linked capture-transportation-storage options (3 months)
- 9: Define scenarios and evaluate outcomes (4 months)

Geologic Carbon Sequestration Options in the Illinois Basin: Phase III (cont'd)

- 10: Compile results in print and digital media
(6 months)
- 11: Carry out education/outreach activities
(5 months)
- 12: Generate action plan for technology validation
activity (5 months)
- All Phase III tasks in Year 2

Illinois Basin Offers Multiple Opportunities to Test Geological CO₂ Sequestration Options

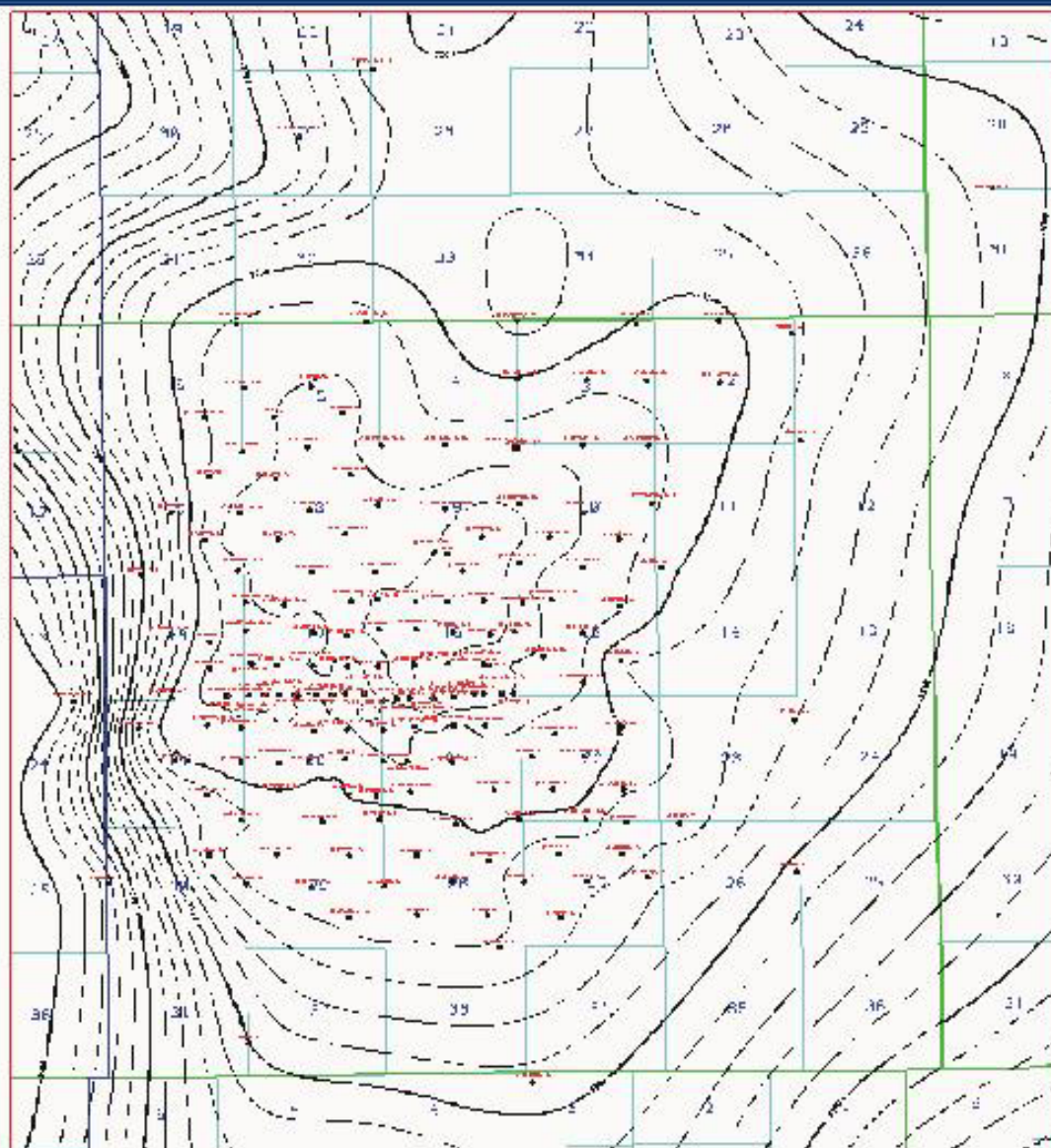
- Potential CO₂ sinks are vertically stacked in much of the central and southern parts of the Illinois Basin
- CO₂ available from ethanol production for field testing
- Illinois has a strong interest in coal redevelopment including gasification processes leading to sequestration-ready CO₂ streams

Mt. Simon Sandstone Supports Natural Gas Storage

- Illinois is the second leading state in natural gas storage capacity in the nation
- Many of these facilities are in the Mt. Simon, proving gas containment capability and providing a data base of cores, water chemistry data, and reservoir engineering properties
- ISGS has completed a Mt. Simon storage facility study for DOE

Manlove Field Geology

- 175 wells in northwest Champaign County, IL
- Depth to top Mt. Simon averages about 4,000 ft
- Porosity 7-15 %, permeability mostly ~ 100 md
- Excellent caprock with 300-400 ft of Eau Claire shale/silt sealing the Mt. Simon



Top Mt. Simon Structure

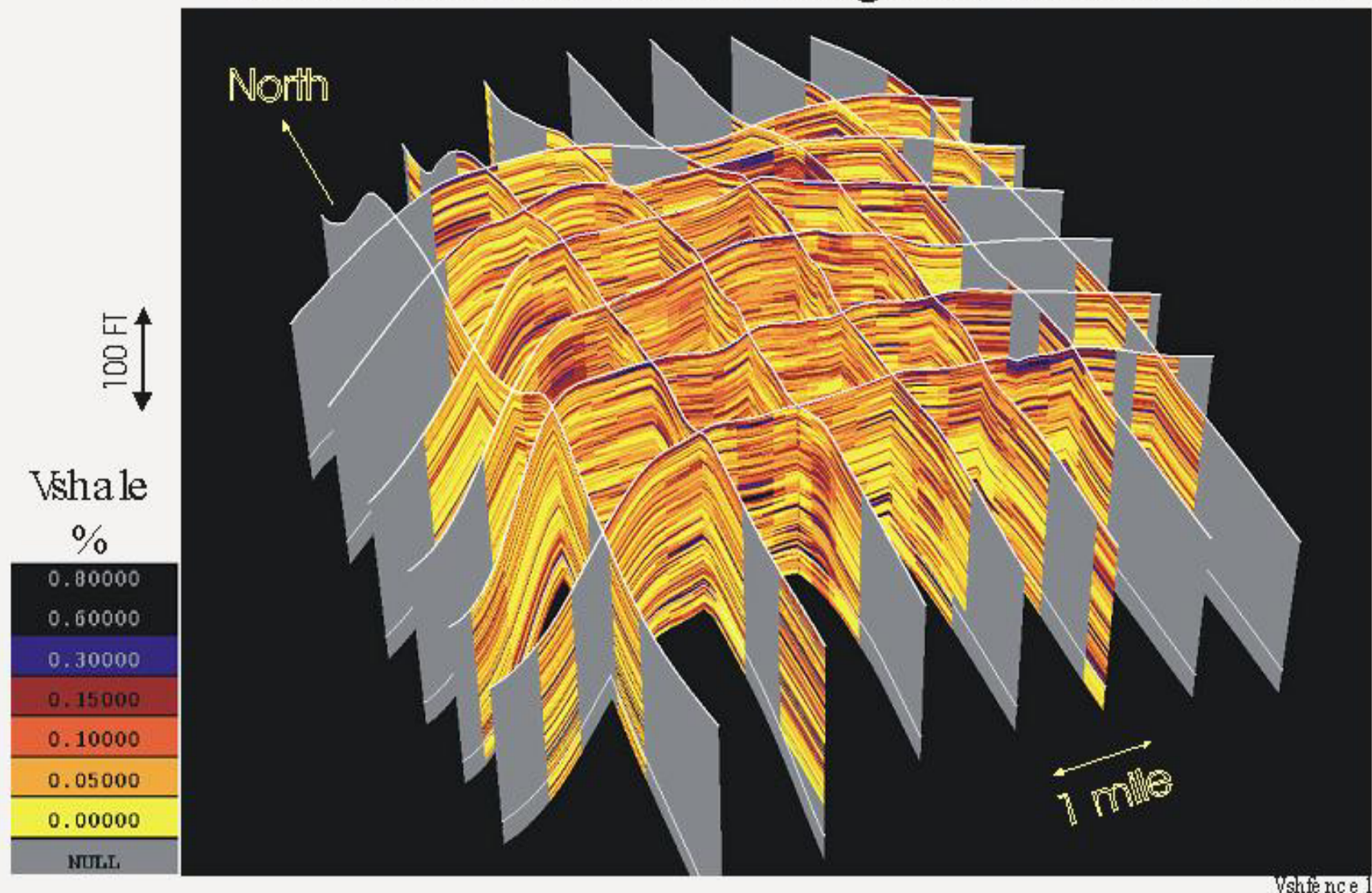


Manlove Field
Champaign Co, IL

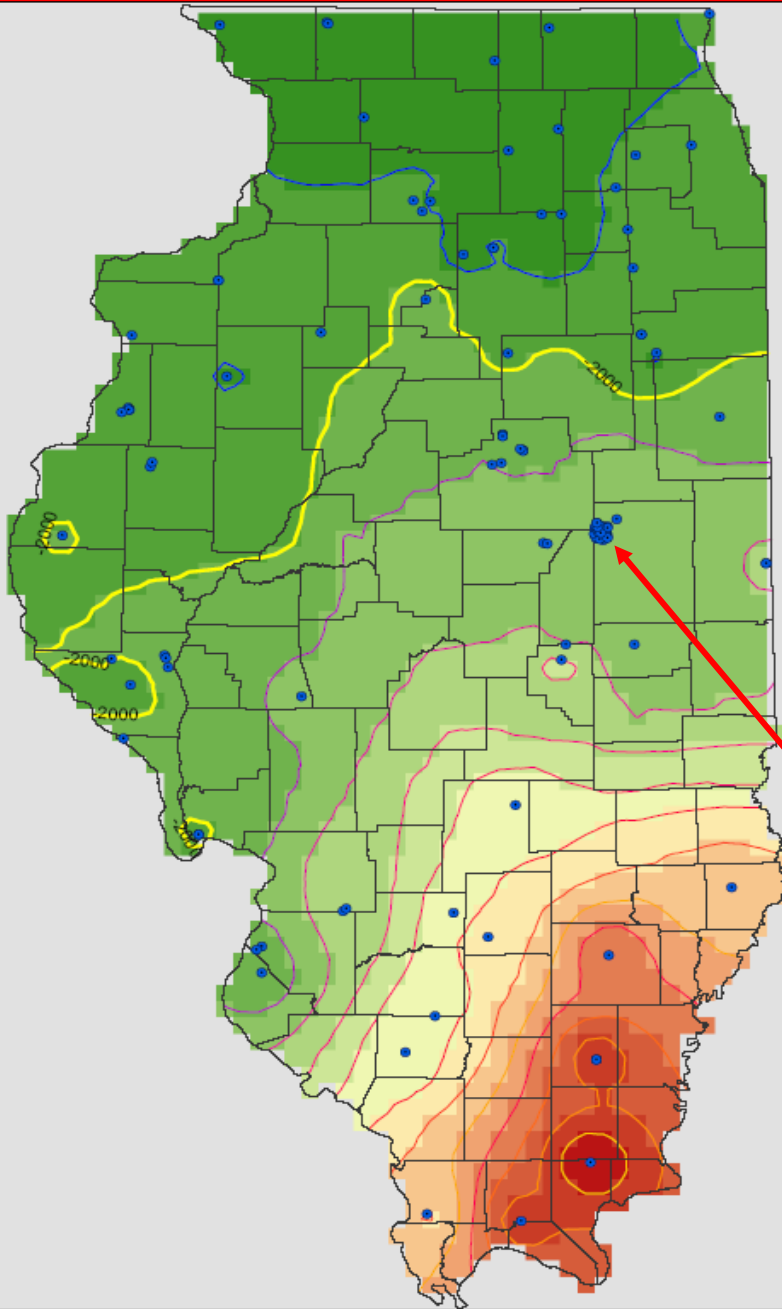
CF= 20 ft

5000'
1 mile

Vshale Structure Fence Diagram- Manlove Field

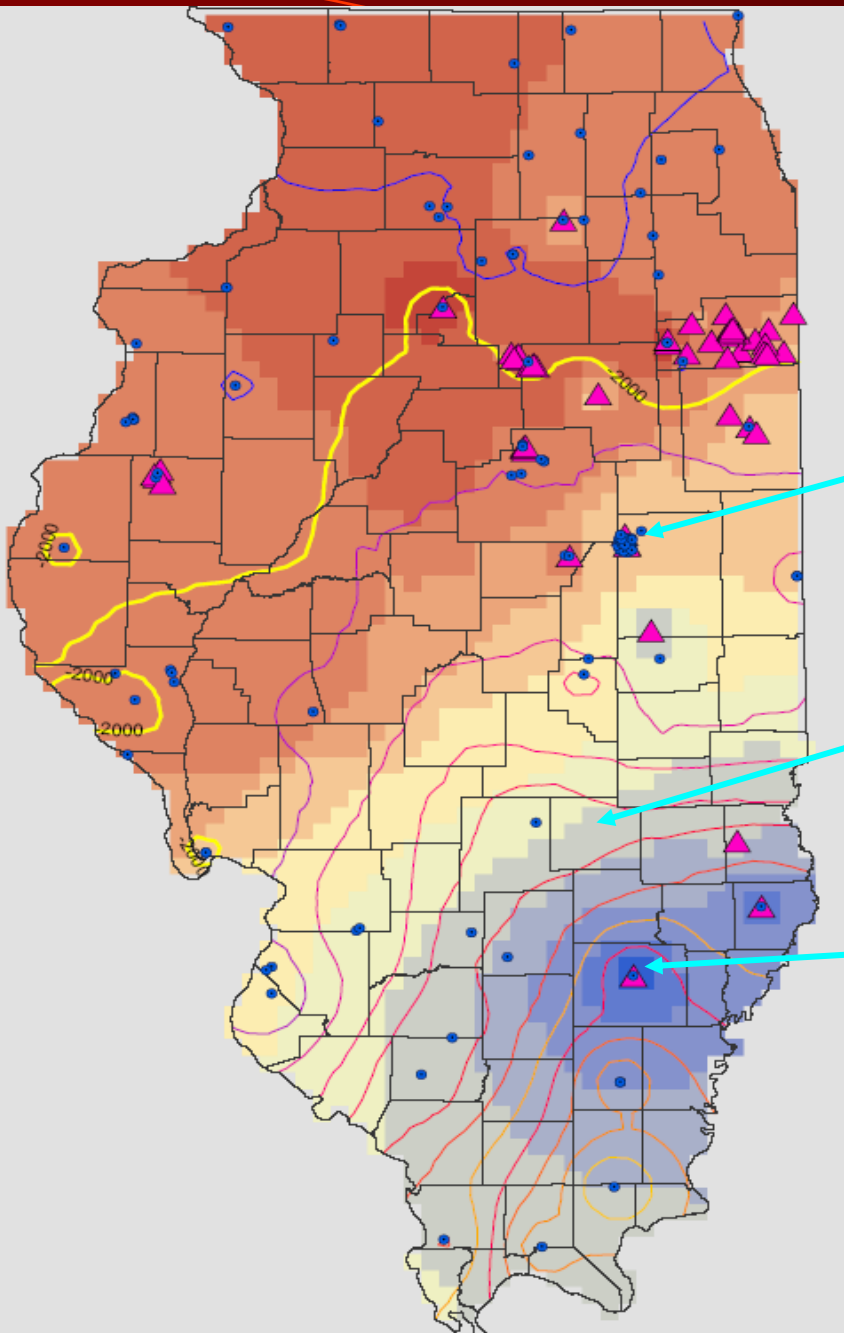


Mt. Simon Structure



- Sub sea depths from $< 1,000$ ft in northern Illinois to $> 13,000$ ft in southeastern Illinois
- Manlove Field southernmost area of detailed data

Mt. Simon Porosity

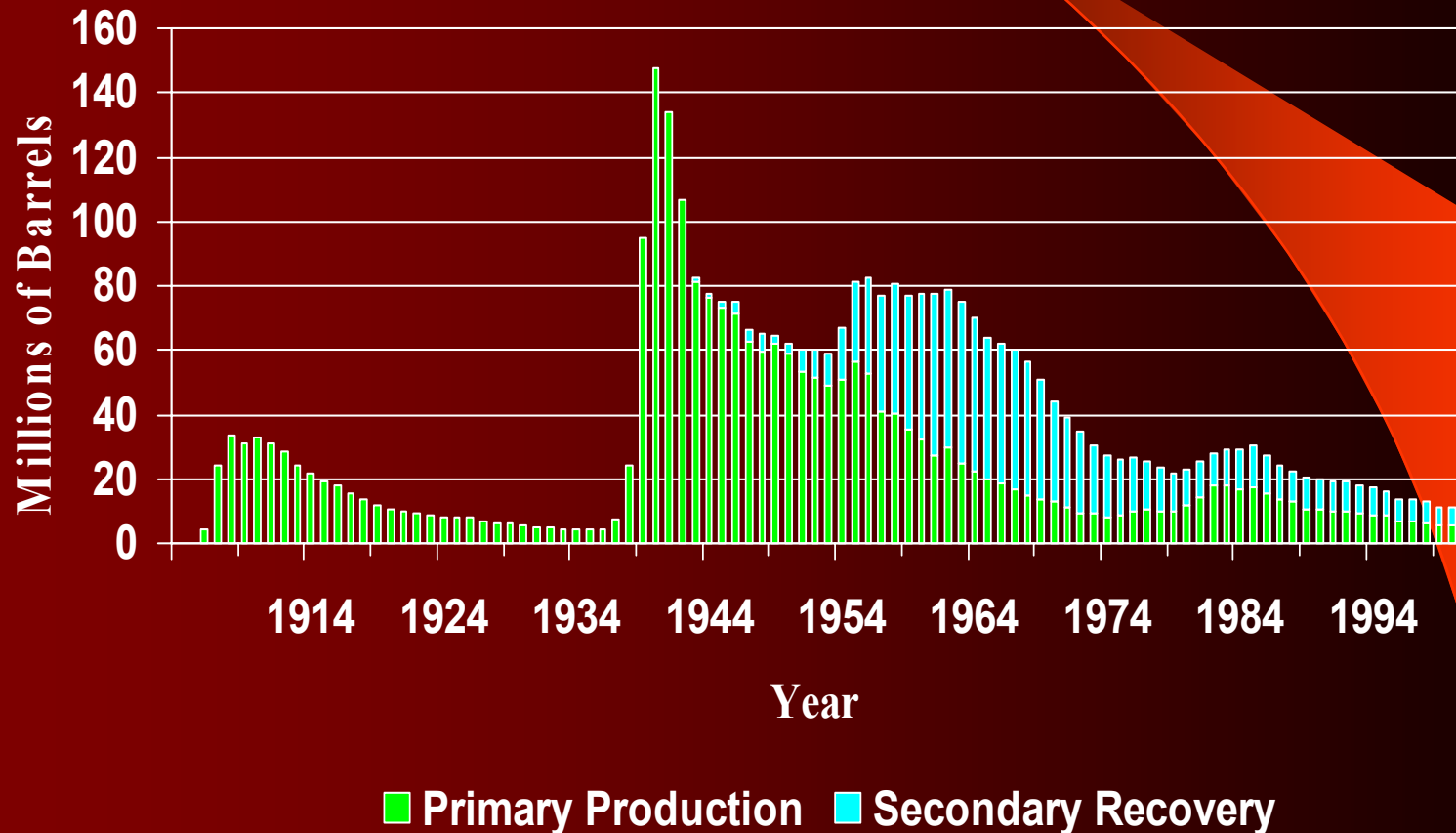


- Porosity at Manlove Field can be up to 15%, mostly 9.5-11%
- Porosity expected to decrease with depth: ~ 7-8% at 8,000 ft
- 3% porosity at deepest locations?

Oil Reservoirs in the Illinois Basin

- Oil industry in Illinois is mature: production declined from 18 mmbbls in 1989 to 11 mmbbls in 2001; peak in 1940 was 140 mmbbls
- Three major reservoirs: Cypress and Aux Vases sandstones and St. Genevieve limestone
- CO₂ flooding largely untested
- Numerous reservoirs depleted

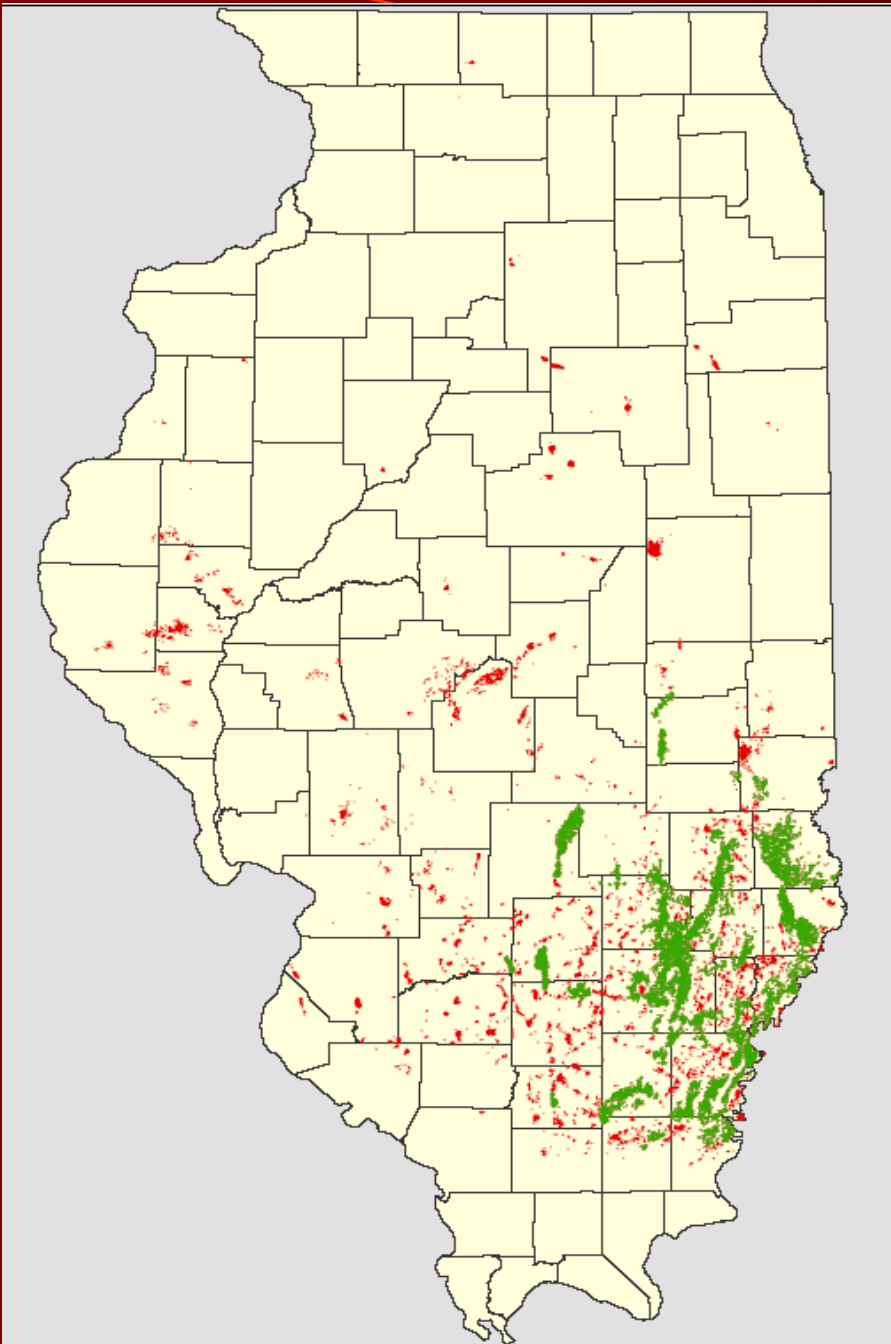
Conventional Production and Waterflood Production have Matured in Illinois



Issues with CO₂ Enhanced Oil Recovery Potential in Illinois

- Most reservoirs in Illinois would be primarily suitable for immiscible flooding
- Some reservoirs would be amenable to miscible flooding at depths $> 2,500$ ft with API oil gravity of 25 or greater
- Uncertain economics have prevented development, particularly the availability of CO₂

Oil Field Distribution



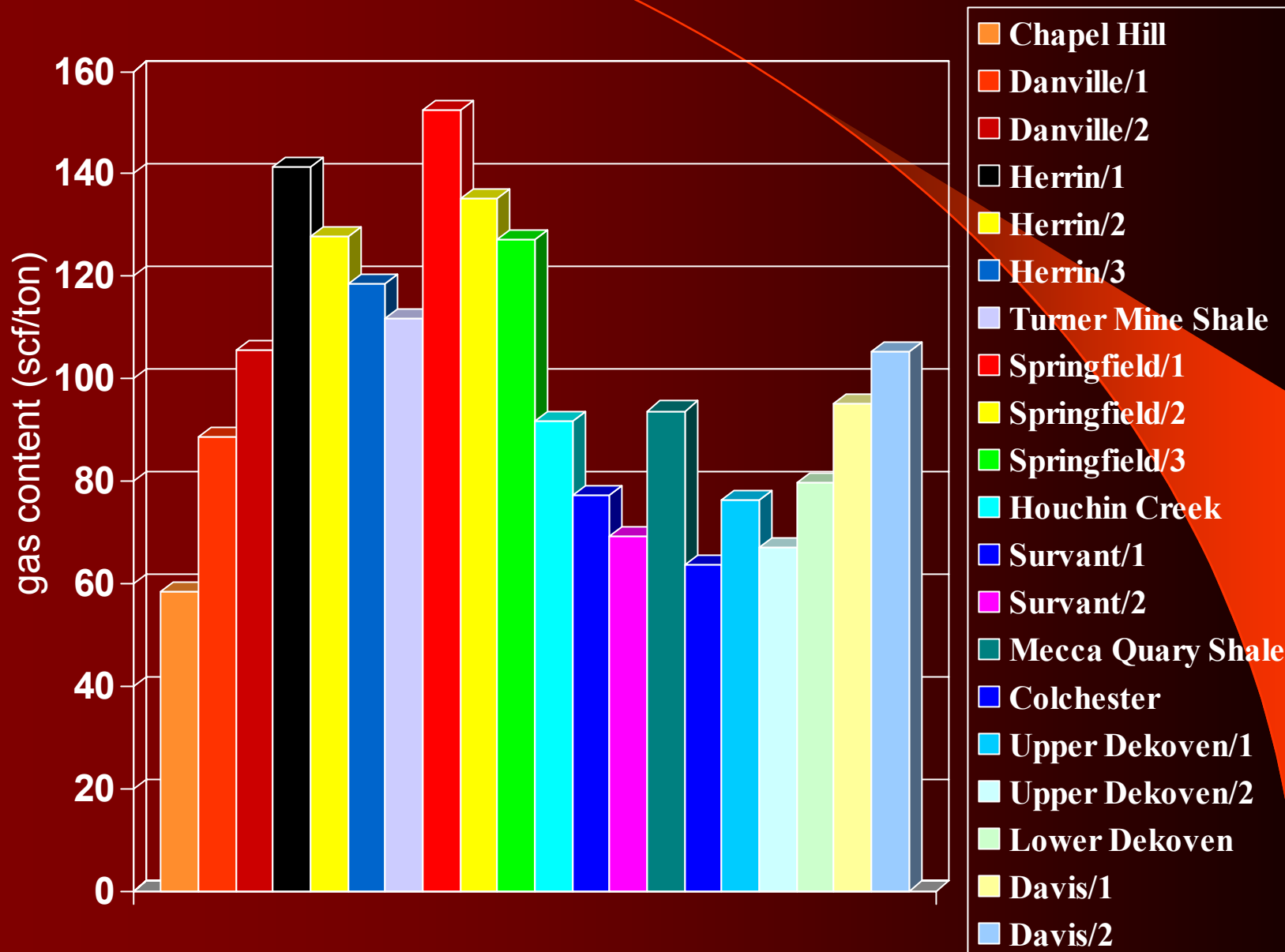
- 559 oil and gas fields shown in red
- 43 large oil fields (green) have one or more reservoirs at $>2,500$ ft depth
- Large fields average > 18 sq mi and have produced ~ 2.4 billion bbls oil

Illinois Contains Extensive Coal Resources

- Coal is mostly hi-vol C and B bituminous
- Over 36,000 sq mi is underlain by multiple seams
- Most bituminous coal of any state
- Two major seams (Herrin and Springfield) and 7 additional seams account for most resources
- Total resources of 199 billion tons of which only 30% economically minable (current and foreseeable future)

Franklin County Gas Contents

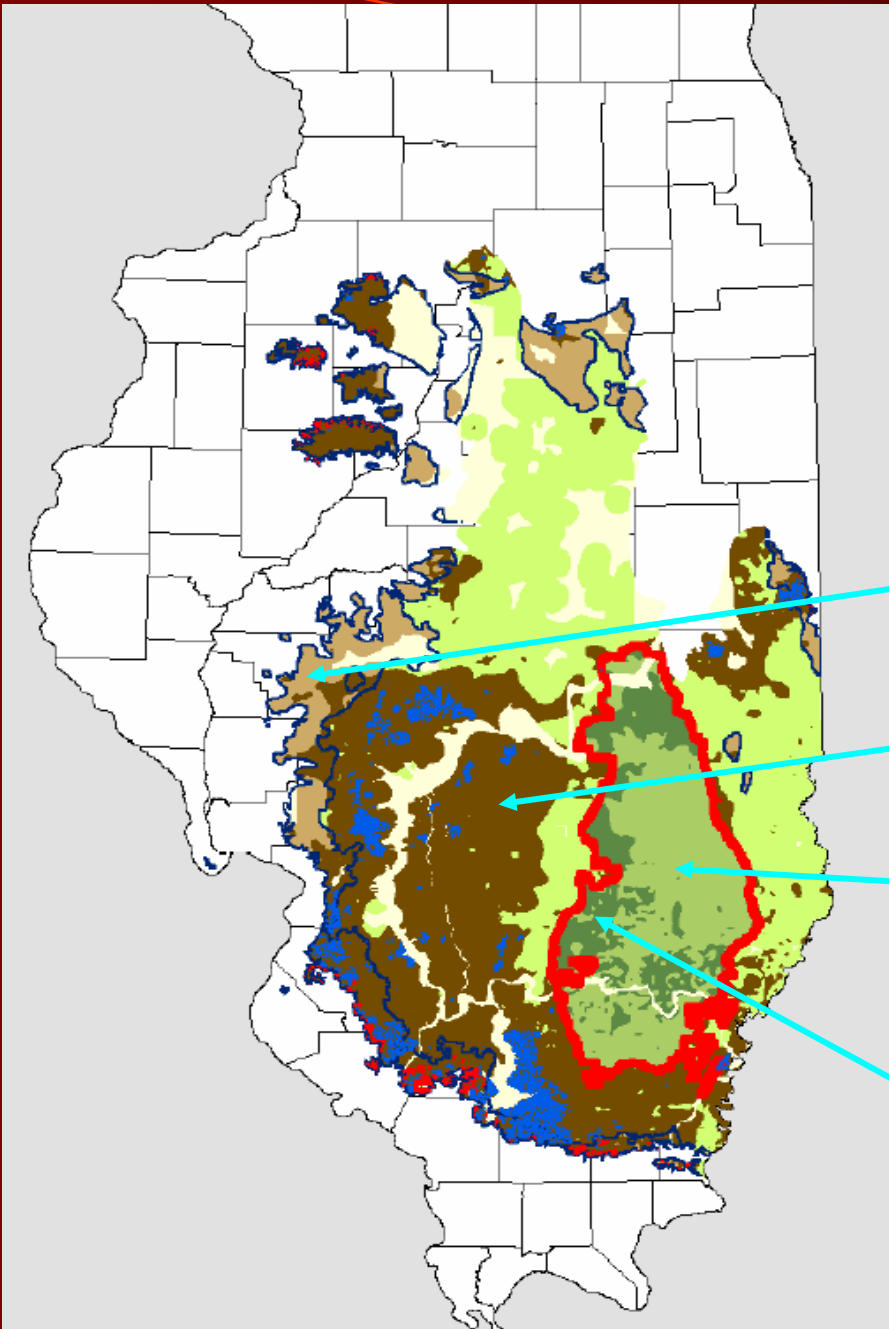
(dry, mineral matter free basis)



Classification Chart

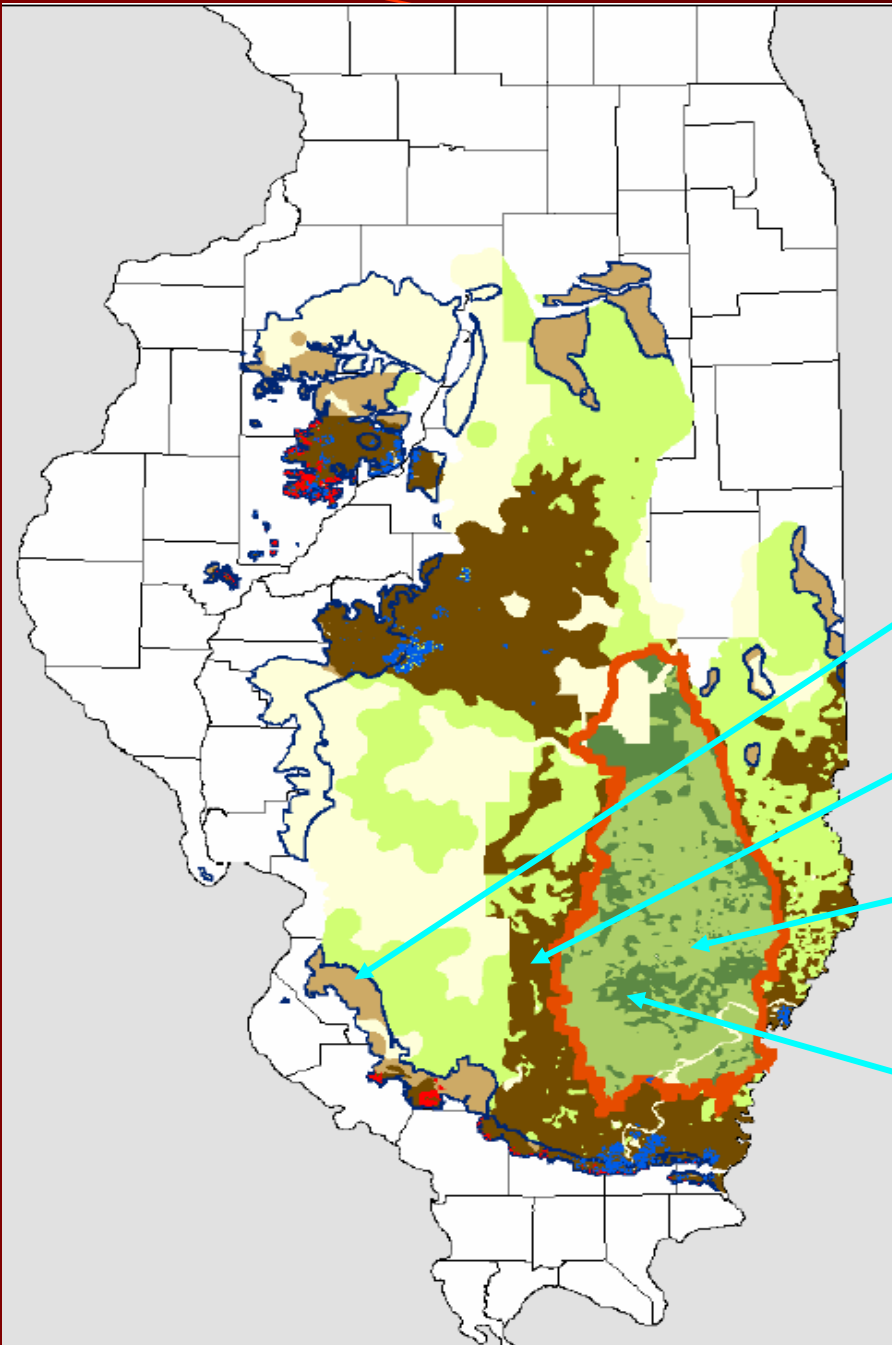
Depth	Thickness	Class
Shallow (Depth < 200 ft)	0" ~ 17"	Thin Coal Seam
	18" ~ 41"	Coal Seam Probably Available for Mining Only
	42" ~ 66"	Coal Seam Available for Mining Only
Moderate (200 ft ≤ Depth < 900 ft)	0" ~ 17"	Thin Coal Seam
	18" ~ 41"	Coal Seam Possibly Available for CO2 Sequestration
	42" ~ 66"	Coal Seam Available for Mining Only
Deep (Depth ≥ 900 ft)	0" ~ 17"	Thin Coal Seam
	18" ~ 41"	Coal Seam Available for CO2 Sequestration
	42" ~ 66"	Coal Seam Probably Available for CO2 Sequestration

Herrin Coal Resources



- Mined areas around basin margin
- Shallow coals are strippable at < 200 ft
- Coal > 42 in thick is minable at 200 to 900 ft
- Coal > 42 in thick and > 900 ft probable for sequestration
- Coal < 42 in thick and > 900 ft most likely sequestration target

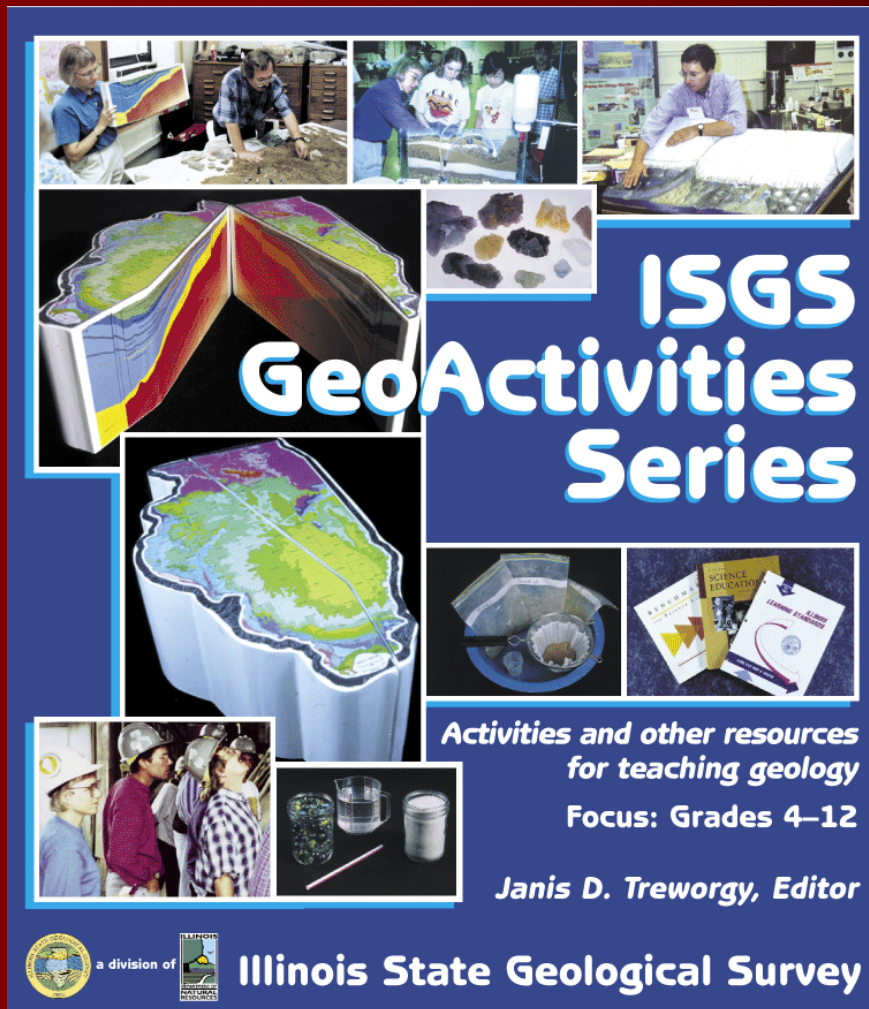
Springfield Coal Resources



- Mined areas at basin margin
- Shallow coals are strippable at < 200 ft
- Coal > 42 in thick is minable at 200 to 900 ft
- Coal > 42 in thick and > 900 ft probable for sequestration
- Coal < 42 in thick and > 900 ft most likely sequestration target

Project Includes Customized Outreach Materials

- *GeoActivities* sequestration module to be created; ISGS workshops reached ~ 5,000 Illinois teachers in the last 4 years; IN and KY Surveys also conduct workshops
- Newsletter contributions for the three O & G associations, EPRI, IOGCC
- Illinois Corn Growers Association reaches 5,000 members throughout the state



Project Outlook

- Project Advisory Group meetings twice annually beginning January 21, 2004
- Web site up by end of Year 1, topical report on capture and transportation
- Carry out extensive outreach activities in last four months with seminars in Springfield, IL and Evansville, IN, final report, 3D models and visualizations, classroom materials, ArcGIS files
- Define plans for an field test of CO₂ injection

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Midwest Regional Carbon Sequestration Partnership

Managing Climate Change and Securing a Future for the Midwest's Industrial Base

Ron Cudnik, MRCSP Project Manager
Battelle Columbus Operations

Presented at the:

Regional Carbon Sequestration Partnership Kickoff Meeting
November 3-4, 2003

The Midwest Regional Carbon Sequestration Partnership



The Midwest Regional Carbon Sequestration Partnership will be the premier resource in the region for identifying the technical, economic, and social considerations associated with and creating viable pathways for the deployment of CO₂ sequestration.

The Midwest Regional Carbon Sequestration Partnership - Goals

Assess the technical and economic potential of carbon sequestration:

- Identify CO₂ sources in the Region
- Assess the cost of capturing CO₂ from these sources
- Assess the Region's deep geologic formations, forests, agricultural and degraded land systems for their potential to sequester CO₂

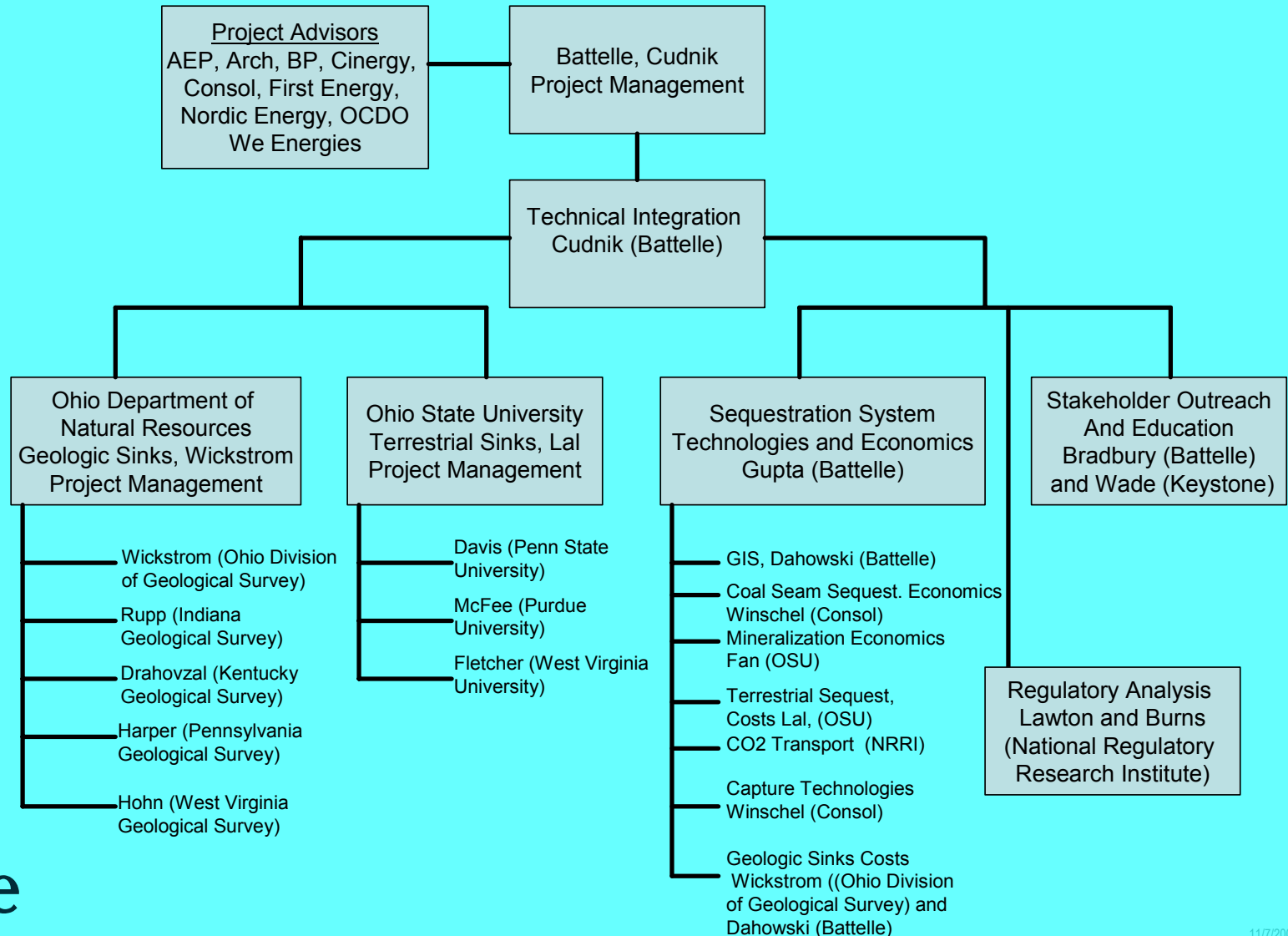
Sequestration must also be socially acceptable:

- Engage the public and elected officials to communicate the potential value of geologic and terrestrial sequestration
- Examine barriers that would hinder cost-effective and timely deployment
- Identify strategies for overcoming these barriers via Phase II field demonstrations

Translate this theoretical knowledge into practical implementation strategies to assist the industries that rely on the region's abundant, reliable, and inexpensive energy sources.

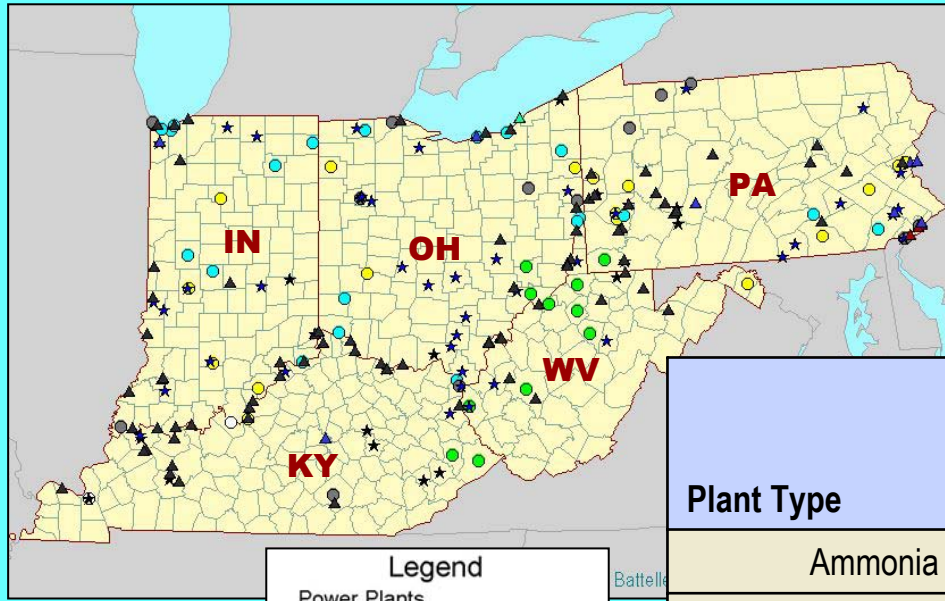
Battelle, OSU, and ODNR

Providing Intellectual Leadership



Large CO₂ Point Sources in the Region

Preliminary Estimate

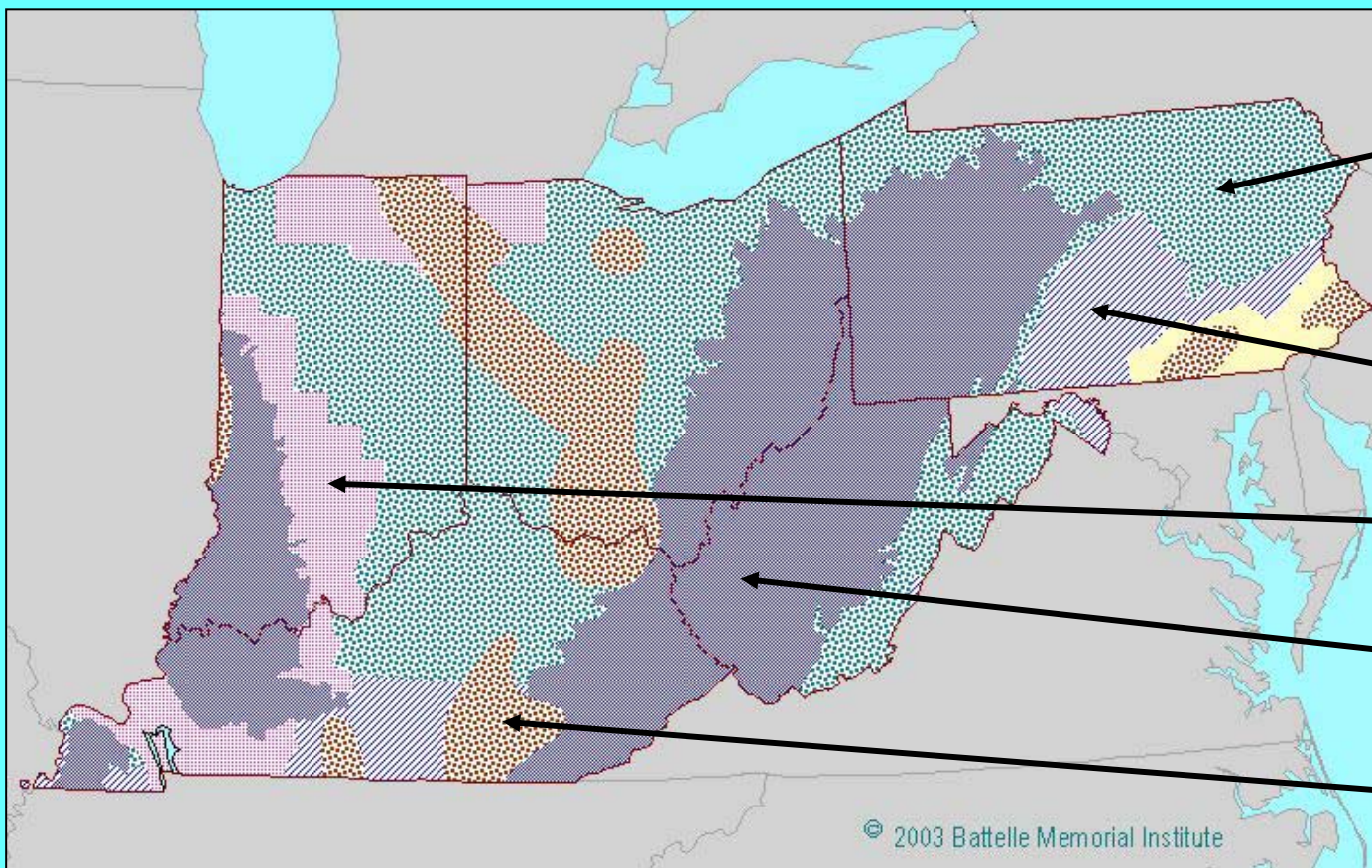


Legend	
Power Plants	
▲	Coal
▲	Nat. Gas
▲	Oil
Planned Power Plants	
★	Coal
★	Nat. Gas
Other Industrial Plants	
●	Ammonia
●	Cement
○	Ethylene & Ethylene Oxide
●	Gas processing
●	Hydrogen
●	Iron & steel
●	Refineries

Plant Type	Midwest Region (IN, OH, KY, WV, and PA)	
	Known Regional CO ₂ Point Sources	Annual CO ₂ Emissions
Ammonia	1	21,000
Cement	20	9,885,000
Ethylene/Ethylene Oxide	4	977,000
Gas Processing	18	9,039,000
Hydrogen	9	448,000
Iron & Steel	57	53,987,000
Power	287	575,445,000
Refineries	16	19,069,000
Total	412	668,899,000

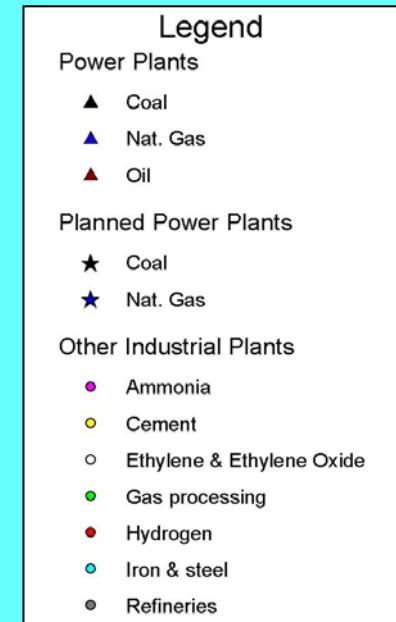
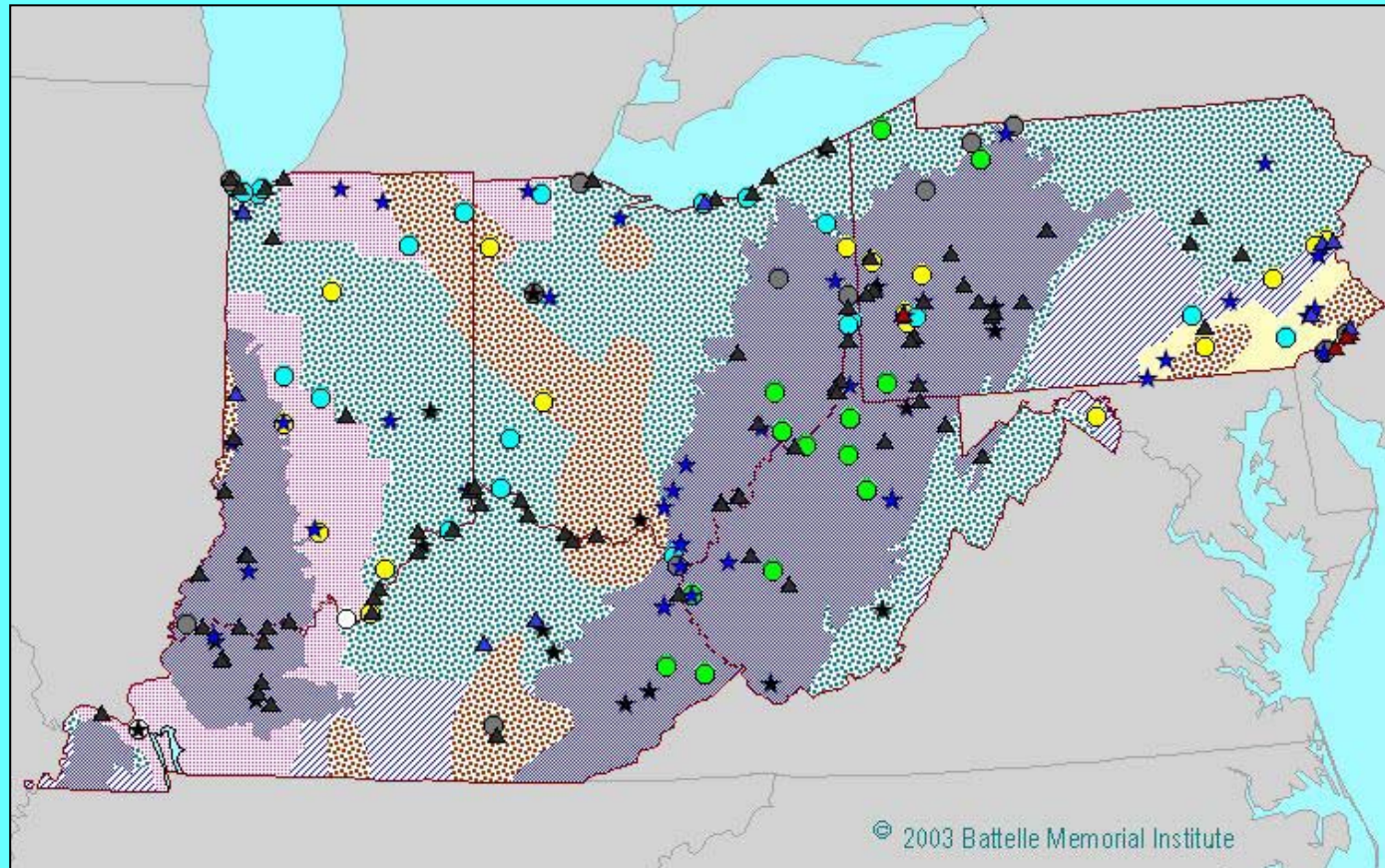
Potential Geologic CO₂ Sequestration Sites

Preliminary Compilation



- Geologic Sequestration
 - Deep Brine-Filled Sedimentary Formations
 - Depleted Gas Fields
 - Depleted Oil Fields
 - Deep Coal Seams
 - Basalt Formations

Good Match Between Point Sources and Geologic Sinks

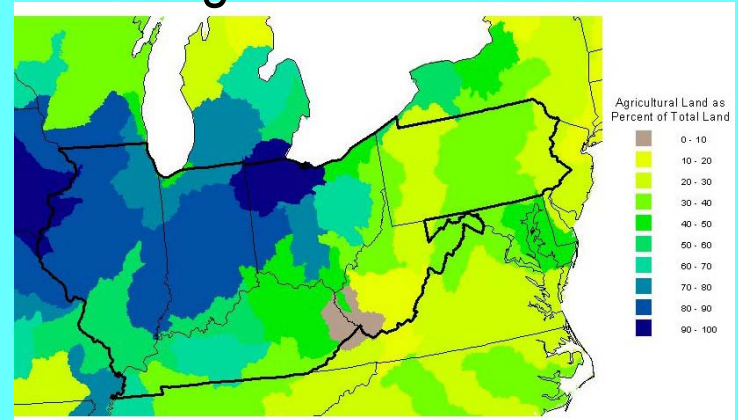


Potential Terrestrial Sequestration Options

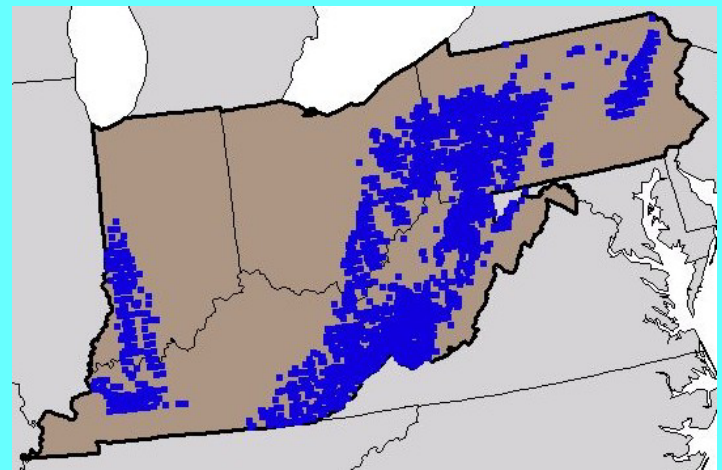
Preliminary Compilation

- Major terrestrial sequestration options to be studied by the Partnership:
 - Agricultural Lands
 - Degraded / Eroded Lands
 - Abandoned Mine Lands
 - Forests

Agricultural Lands



Abandoned Mine Lands



Develop a Broad Understanding of How Sequestration Systems will Deploy in the Region

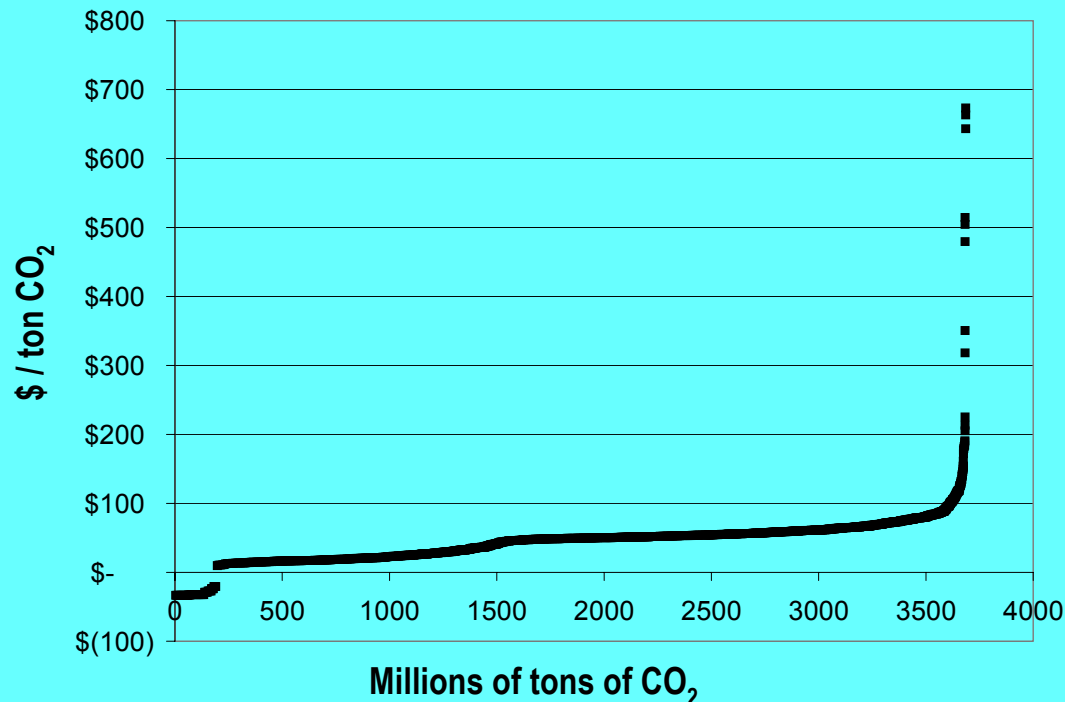
- Fact Finding:
 - Identify and address issues for technology deployment, including safety, economics, regulations, public perceptions, environmental impacts, monitoring, and verification
 - Develop public involvement and educational methodologies and supporting materials in order to raise public awareness of Regional sequestration needs and opportunities, and provide stakeholders with information regarding technology development efforts

- Laying the Foundation for a successful Phase II
 - Identify promising options for CO₂ capture, transport, and sequestration on the basis of technical feasibility, safety, estimated cost, perceived public acceptability, CO₂ reduction potential, and environmental efficacy
 - Prepare action plans for involving and educating the public regarding sequestration opportunities and for informing interested stakeholders about the planned technology development efforts
 - Prepare action plans for implementing and validating small-scale field tests of sequestration options in the Midwest Region in Phase II.

Develop a Cost Methodology that Works for Both Terrestrial and Geologic Sequestration

- Develop methodology for estimating costs of sequestration options
 - Terrestrial options
 - Deep saline formations
 - Coal seams
 - Depleted Oil and Gas Fields
 - Enhanced oil recovery
 - CO₂ mineralization
 - CO₂ capture from a number of industrial processes
- Implement methodology using data collected and organized with respect to potential sequestration reservoirs
- Ultimately create a cost based listing of Region's sequestration options

Cost Methodology Will Help Answer Many Pressing Questions About Sequestration

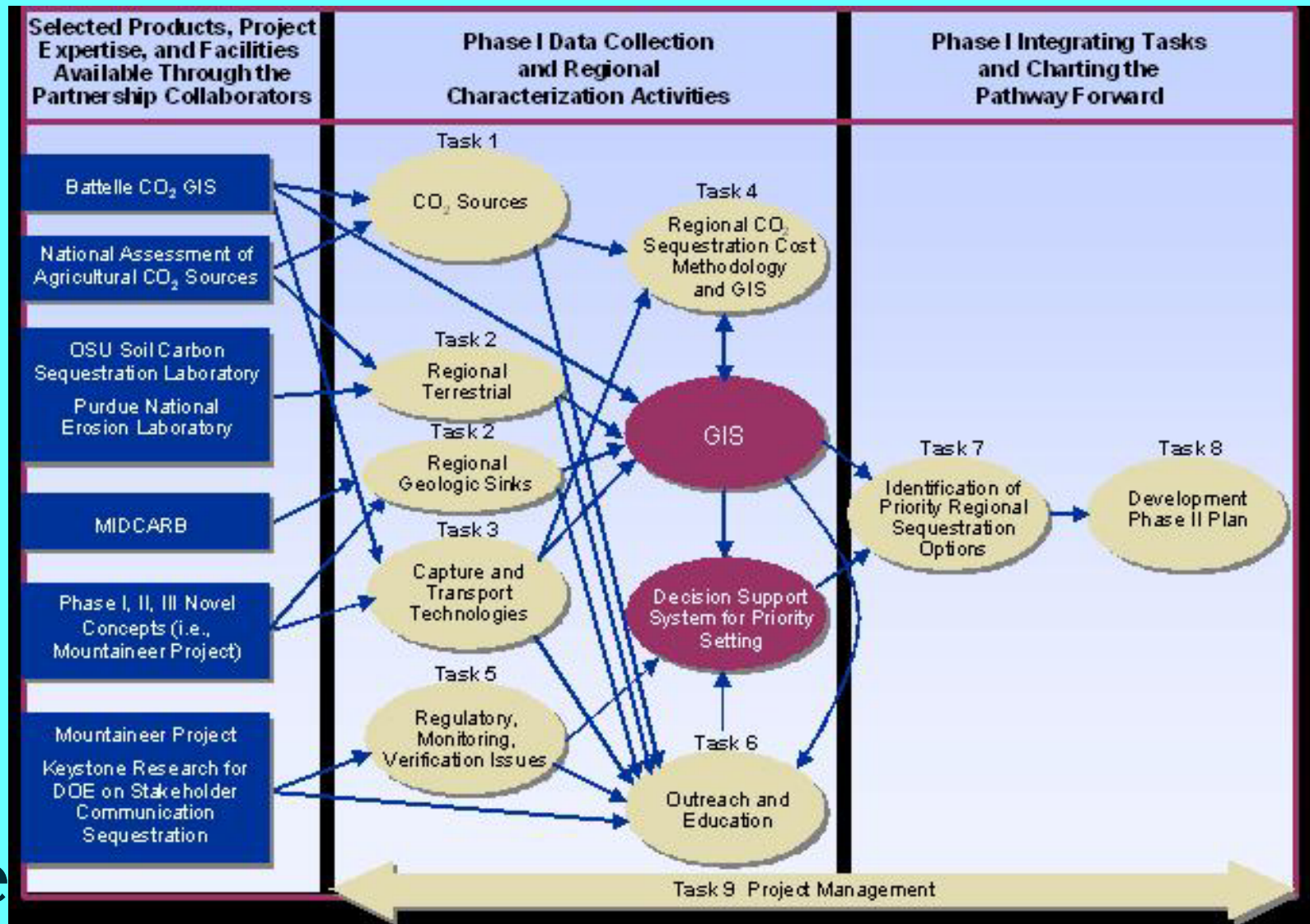


- How many million tons of CO₂ sequestration are available at a given price?
- Is there “enough” sequestration capacity in the Region?
- When (and at what prices) does the region import or export carbon permits?

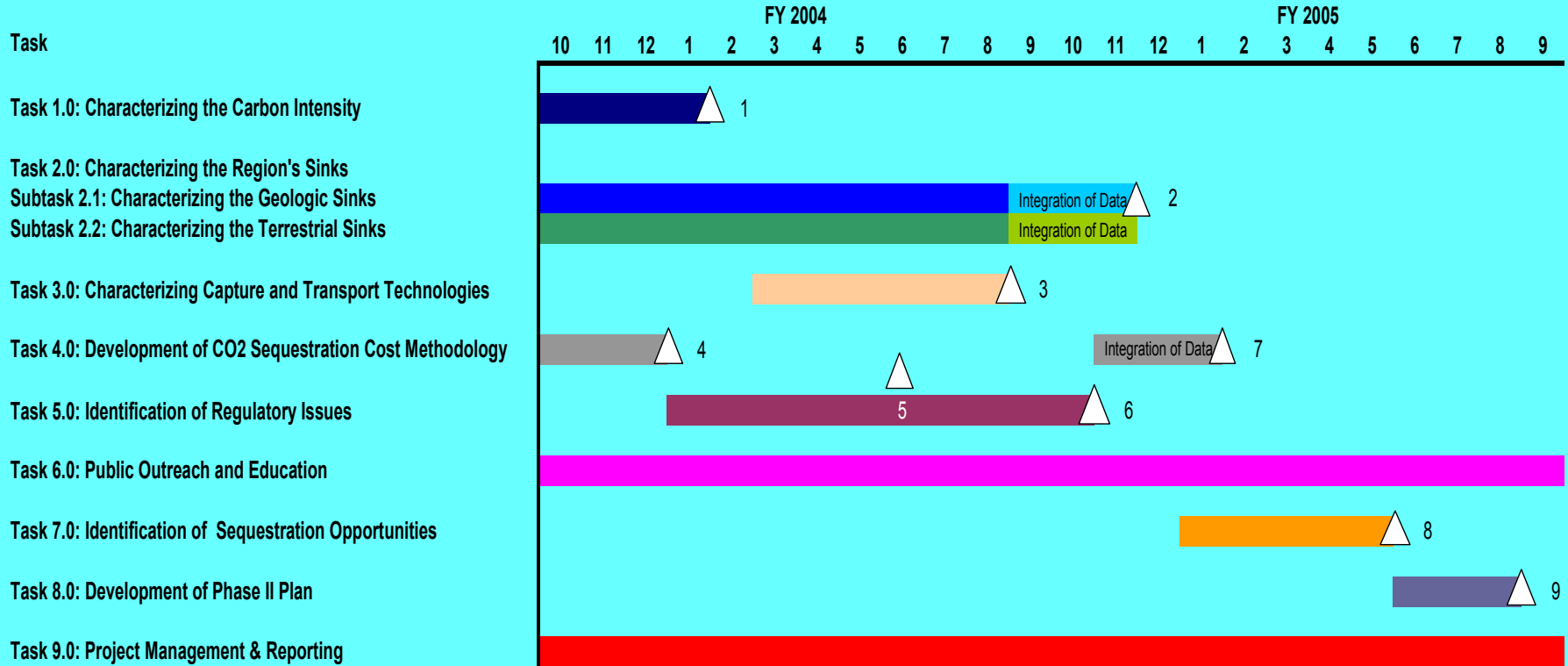
But Cost Will Not Be the Only Criterion for Deploying Sequestration within the Region

- Therefore we must collaboratively develop the Phase II Plan with all sponsors and stakeholders
 - The project team will develop a full listing of Region's sequestration options
 - We will prepare a draft multi-criteria methodology that will be used to define a focused set of Regional priority projects
 - Cost per ton
 - Ability to utilize existing infrastructure
 - Strong industrial / DOE support
 - Relevance for the Region's future
 - Broad stakeholder input
 - Ability to develop knowledge needed for science-based sequestration regulations
 - Hold a workshop with sponsors and stakeholders to confirm and apply methodology
 - We will document the results of the workshop and develop the Phase II Plan

A Quick Start and Higher Value-Added Deliverables, Because Partnership Team Members Are Conducting Highly Relevant Research Right Now



Proposed Schedule



1 Carbon Intensity of the Region Characterized

2 Assessment of Geologic and Terrestrial Sequestration Reservoirs Potential and Associated Issues Documented; GIS-Compatible Sequestration Data

3 Capture and Transport Technologies Characterized

4 Sequestration Cost Methodologies Developed

5 Current Regional Regulatory Issues Identified

6 Framework for Future Regulatory System

7 GIS Functional

8 Regional Sequestration Opportunities Identified

9 Phase II Plan Developed

The Partnership: Delivering Solutions

- The Partnership will define the real world potential and what it will take to realize this potential for carbon sequestration in the Region.
- These sequestration technologies are needed to protect core economic assets in the Region in a greenhouse gas constrained world.
- The Partnership brings together internationally recognized research leaders to help define real world carbon management solutions.
- The Partnership's research will help its customers take a first step towards the avoidance of a potential multi-hundred million if not multi-billion dollar future problem.
- The Partnership's work will allow its sponsors to position themselves as leaders in developing robust carbon management solutions.

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Southern States Energy Board

Southeast Regional Carbon Sequestration Partnership

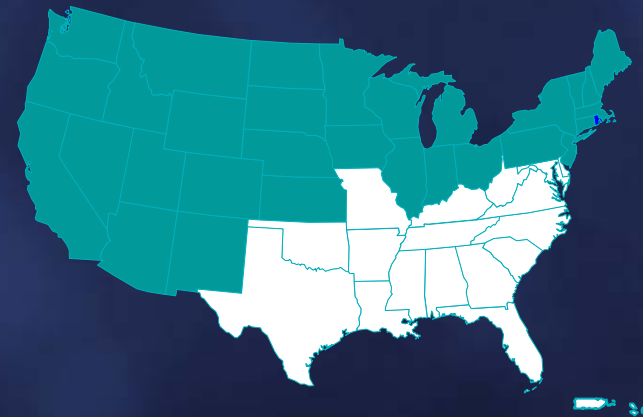
Project Overview
DE-PS26-O3NT41980

Kenneth J. Nemeth
Executive Director
Southern States Energy Board
November 3, 2003
Pittsburgh, Pennsylvania



Southern States Energy Board (SSEB)

- Non-profit, interstate compact organization established in 1960 by PL87-563 and 92-440
- Mission: “Through innovations in energy and environmental programs and technologies, the Southern States
- Energy Board enhances economic development and the quality of life in the South”
- Membership:
 - 16 U.S. States and 2 Territories
 - Each jurisdiction is represented by the governor, a legislator from the House and Senate and a governor’s alternate.
 - Federal Representative appointed by the U.S. President



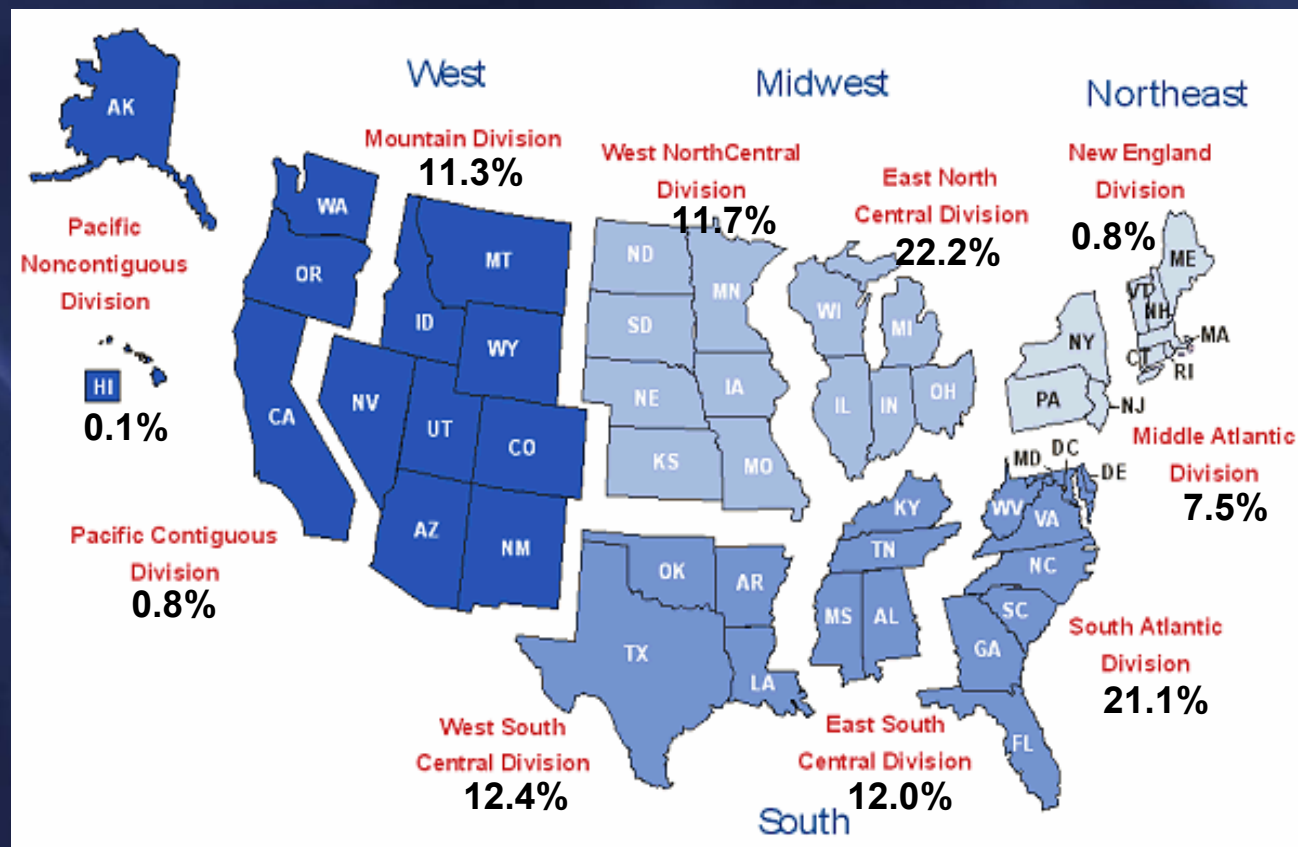
Southern States Energy Board (SSEB)

SSEB's technology programs assist the region's stakeholders in addressing energy and environmental issues that transcend state boundaries and provide direct benefit to individual states.

- Clean Coal and Advanced Power Systems
- Water-Energy Interface
- Interstate Technology Regulatory Council
- Distributed Energy Resources
- Electric Utility Restructuring
- Pipeline Safety
- Greenhouse Gases and Carbon Management
- Permitting Leadership in the United States
- Radioactive Materials Transportation
- Southern States Waste Management Coalition
- Southern Emergency Response Council
- Associate Members/Utility Advisory Council



CO₂ Emissions by U.S. Census Regions



Carbon Dioxide Emissions and SSEB

- In the SSEB region, coal is the primary fuel for electricity in 13 states.
- Forty-four percent (44%) of total U.S. CO₂ emissions originate from sources in SSEB member states.
- Total value of 1999 CO₂ emissions in the SSEB region was 1,218,579 thousand short tons.
- Significant potential for terrestrial and geologic sequestration sinks in the SSEB region
- Significant opportunities for value-added CO₂ sequestration

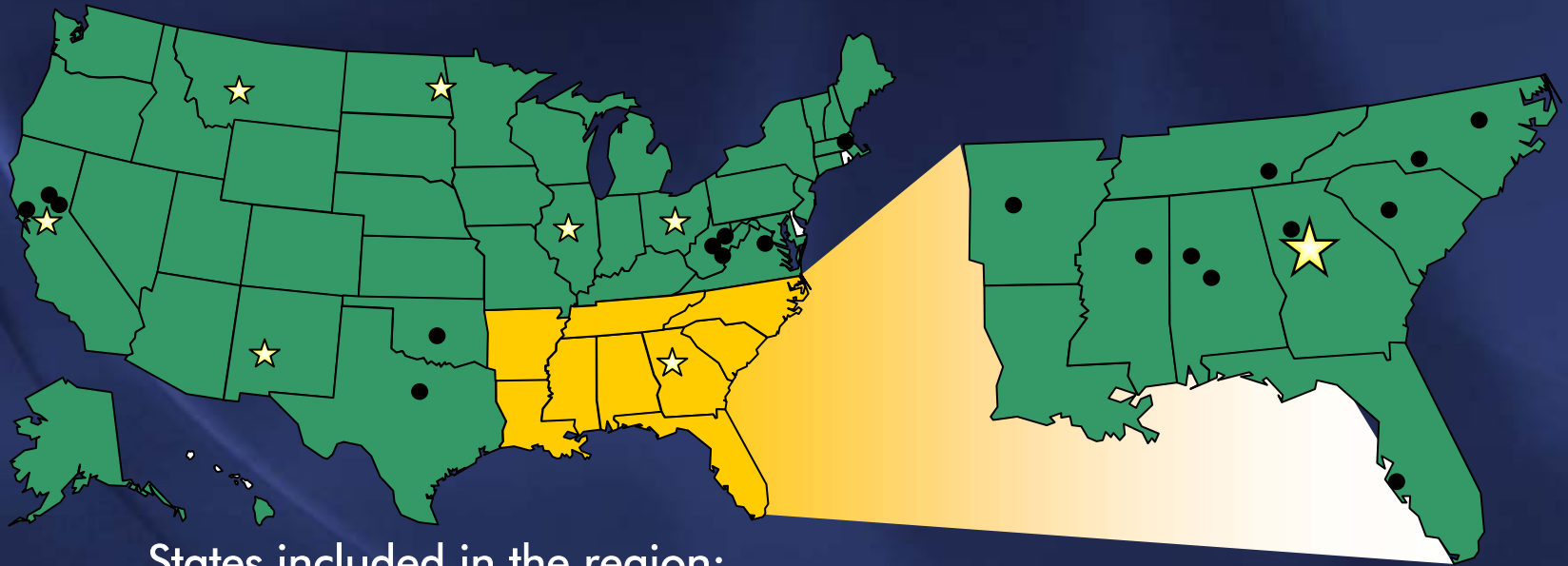


Importance of DOE Region Carbon Sequestration Partnerships (RCSP) to SSEB

- Research entities and technology businesses located in the SSEB region are playing key roles in DOE research.
- Sequestration technology innovation and cost-effective implementation are key to economic growth in the SSEB region.
- Due to the importance of sequestration to the SSEB region and its member states, industries and citizens, SSEB must play an active role in RCSP formation, response and activities.



Southeast Regional Carbon Sequestration Partnership



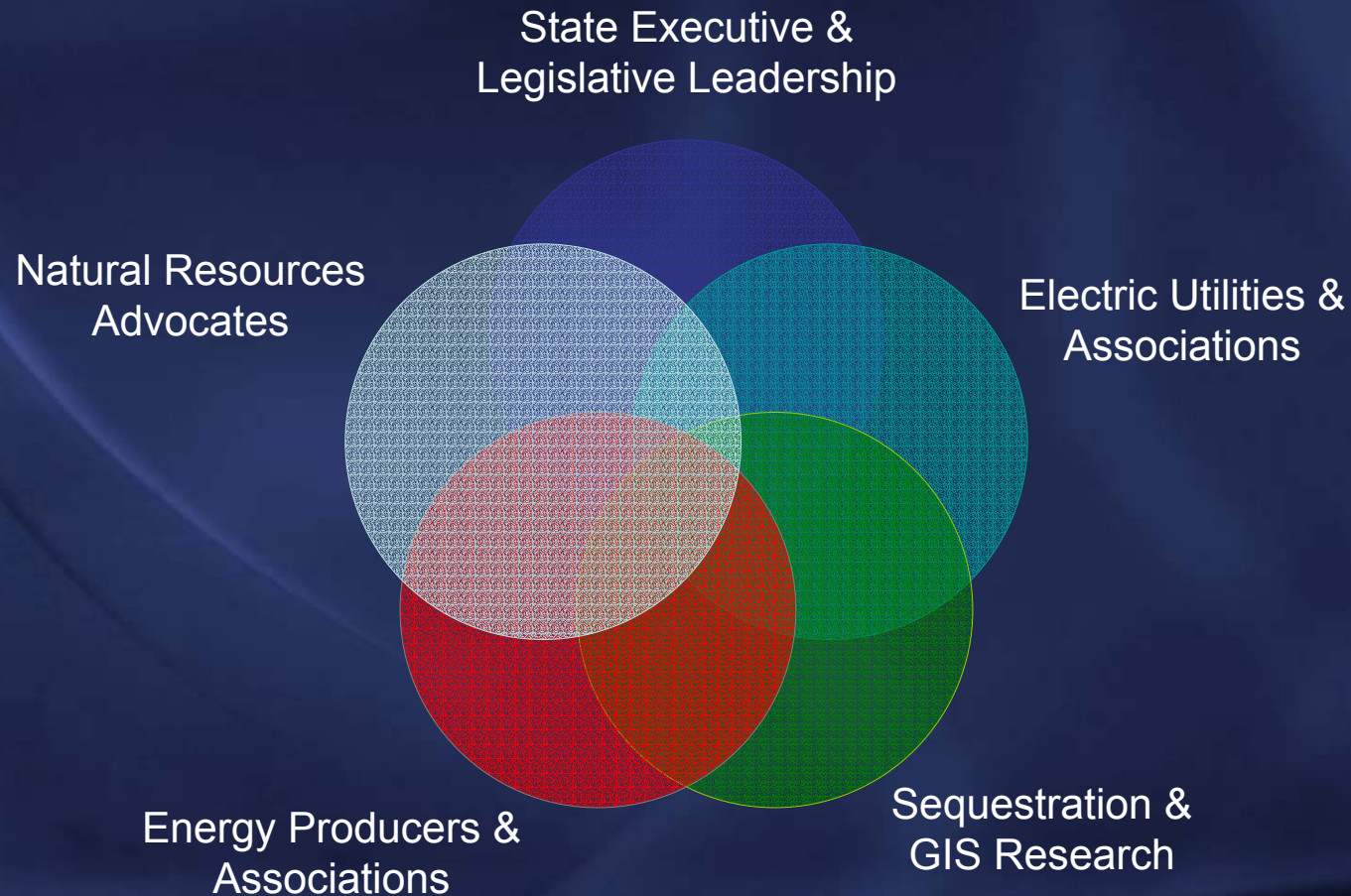
States included in the region:

Alabama
Florida
Louisiana
North Carolina
Tennessee

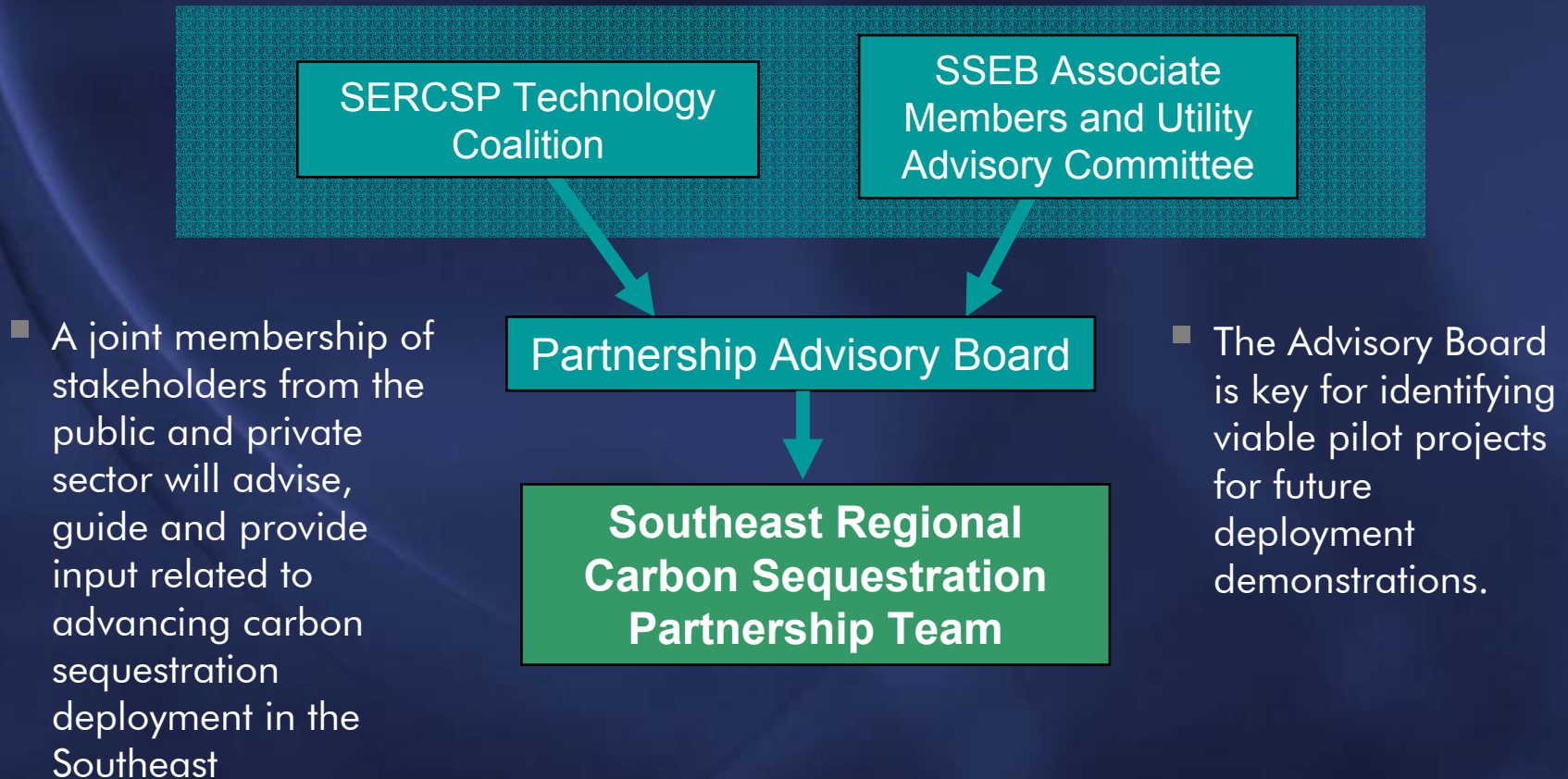
Arkansas
Georgia
Mississippi
South Carolina



Partnership Structure



Partnership Advisory Board



Technology Coalition

The Hon. Mike Huckabee (AR Gov.)
The Hon. Mike Foster (LA Gov.)
The Hon. Ronnie Musgrove (MS Gov.)
Representative Jerry Paul, Florida

Arkansas Oil and Gas Commission
Georgia Environmental Facilities Authority
Georgia Forestry Commission
Louisiana Department of Environmental Quality
North Carolina Energy Office
South Carolina Department of Agriculture

Duke Power
Progress Energy
SCANA Energy
Southern Company
Tampa Electric Company

Interstate Oil and Gas Compact Commission
The North American Coal Corporation
Center for Energy and Economic Development
Clean Energy Systems, Inc.

Interstate Oil and Gas Compact Commission
The North American Coal Corporation
Center for Energy and Economic Development
Oak Ridge National Laboratory
Clean Energy Systems, Inc.

State Executive & Legislative Leadership

Natural Resources Advocates

Electric Utilities & Associations

Energy Producers & Associations

Sequestration & GIS Research

Technical Team

SSEB Governors
SSEB Federal Representative
SSEB Legislative Members

Geologic Survey of Alabama
Susan Rice and Associates

EPRI
Tennessee Valley Authority

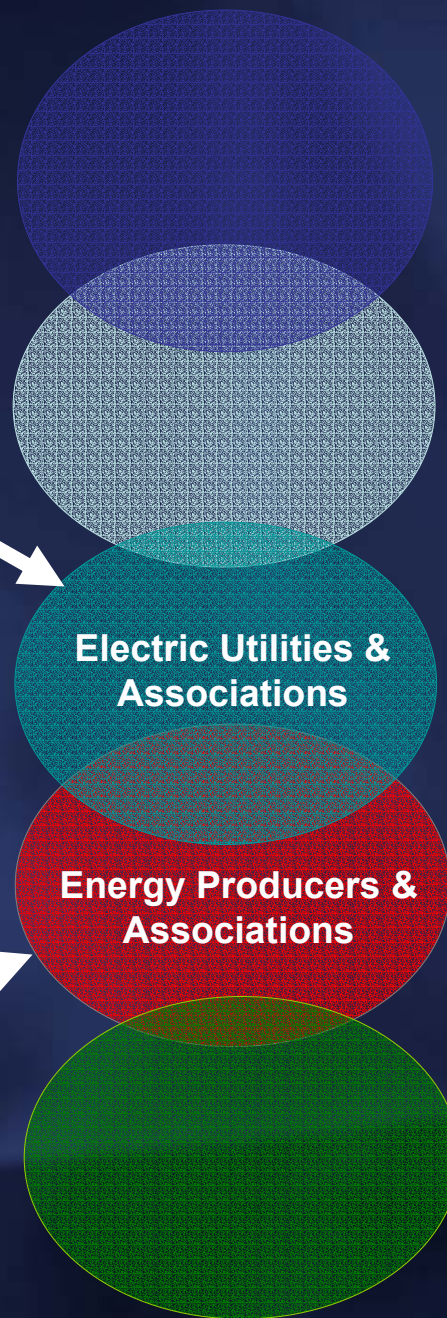
Advanced Resources International
Augusta Systems, Inc.

MSU-DIAL
Applied Geo Technologies
MIT
Winrock International
NETL

SSEB Associate Members/ Utility Advisory Committee

American Electric Power
Dominion Energy
Edison Electric Institute
Entergy Services
Florida Power and Light
Nuclear Energy Institute
Old Dominion Electric Cooperative
Progress Energy
SCANA Corp
Santee Cooper
Southern Company
TECO Services
Tennessee Valley Authority

AGL Resources
BP America
Center for Energy and Economic Development
Chevron Texaco Corp
Dominion Resources



Partnership Technical Team Qualifications



■ Southern States Energy Board

- Only interstate compact in the U.S. that is constituted by both federal and state laws that has governors, legislators and a Presidential appointee comprising its board of directors
- 43+ years experience effectively addressing energy and environmental issues that transcend state lines and require a regional or national approach
- Project partnerships are at the core of all SSEB committees/task forces



Partnership Technical Team Qualifications



- Electric Power Research Institute (EPRI)
 - Creates science and technology solutions for the global energy and energy services industry
 - Multidisciplinary teams of scientists and engineers draw on a global network of expertise to solve today's toughest energy and environmental problems
 - Only science and technology consortium serving the entire power industry



Partnership Technical Team Qualifications



- Mississippi State University Diagnostic Instrumentation Analysis Laboratory (MSU-DIAL)
 - National leader in evaluation of advanced energy processes and systems and in identifying methods to reduce emissions
 - Unique testing and instrumentation capabilities in these evaluations, primarily aimed at achieving optimal control of the process and product.



Partnership Technical Team Qualifications



- Augusta Systems, Inc.
 - Aids clients, including NETL in characterizing the potential for geologic CO₂ storage and assessing tools available for greenhouse gas and carbon emissions strategic planning
 - Expert staff with experience in science and engineering companies, academia, research institutions and state and federal government to help clients meet greenhouse gas emissions management goals



Partnership Technical Team Qualifications

- **Massachusetts Institute of Technology (MIT)**
 - Dedicated to advancing knowledge and educating students in science, technology and other areas of scholarship that will best serve the nation and the world in the 21st century
 - Since 1989, MIT has conducted research into technologies to capture and sequester CO₂ from large stationary sources
- **Tennessee Valley Authority Public Policy Institute (TVA-PPI)**
 - TVA's electric system assets are used as a living laboratory to develop and demonstrate technologies and strategies that focus on improving reliability and efficiency throughout the system
 - PPI Greenhouse Gas Team provides input on policies and assesses strategies and technologies for reducing or offsetting greenhouse gas emissions



Partnership Technical Team Qualifications

- Winrock International

- Nationally and internationally recognized as an authoritative partner in the development and implementation of programs related to sound analysis and scientific measurement of carbon sequestration
- Long tradition of work in agriculture, forestry, natural resource management and clean energy and committed to applying the best available science and economics to find solutions to the world's development problems



Partnership Technical Team Qualifications

- **Applied Geo Technologies (AGT)**
 - Premier Native American-owned digital mapping company that provides hi-tech opportunities for its people
 - Leading provider of geospatial data and related services
- **Geologic Survey of Alabama (GSA)**
 - Extensive research in the area of petroleum and carbon sequestration have included reservoir characterization, coalbed methane, reserve studies, oil geochemistry and source rock evaluation, engineering studies and determination of the carbon sequestration potential of coalbed methane reserves
- **Susan Rice and Associates (SARA)**
 - Expert evaluation of health issues, including research and development in toxicology, pharmacology and related fields



Partnership Technical Team Qualifications

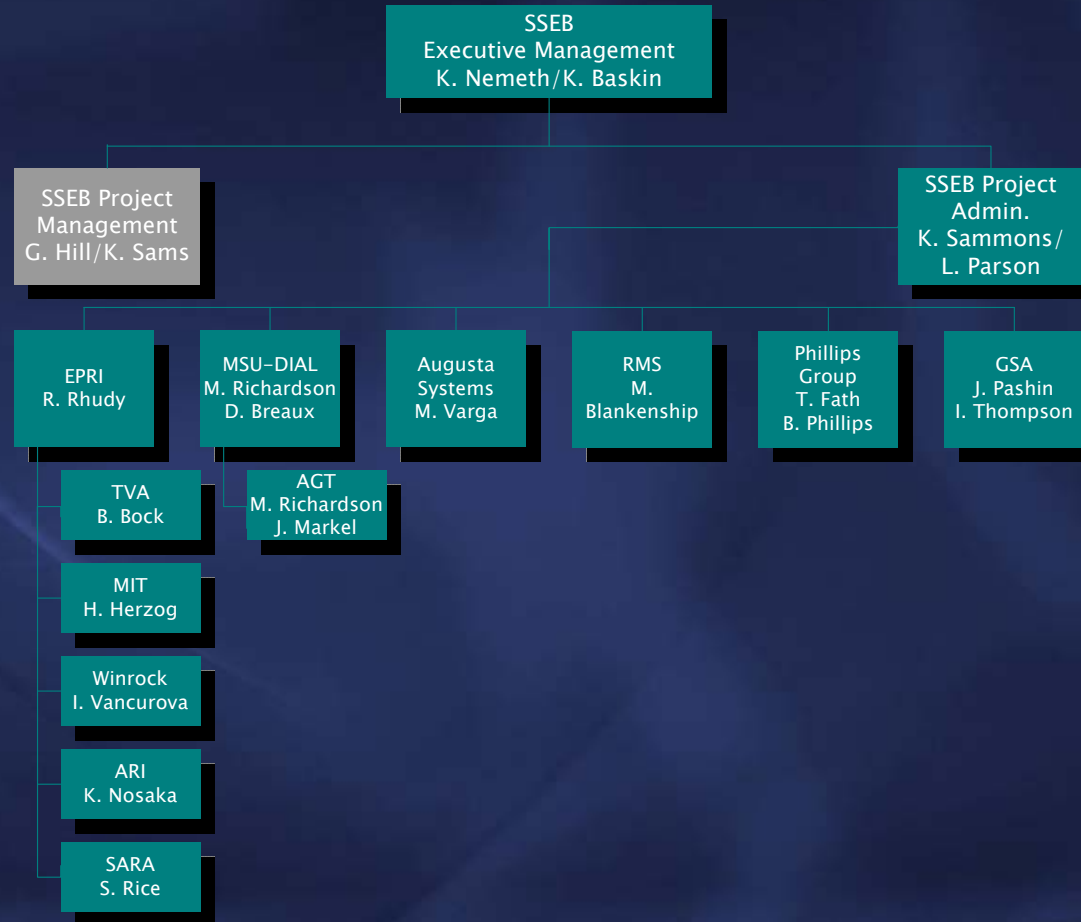
- Advanced Resources International (ARI)
 - Leader in the development and evaluation of geologic sequestration of CO₂
 - Geologic and engineering service provider to the petroleum industry and R&D on upstream oil and gas exploration and extraction technologies
- The Phillips Group
 - Expertise in providing services in strategic communications counsel and public relations management
- RMS Research (RMS)
 - Prominent high profile communications strategy development and implementation to support decision making for clients in more than 30 states



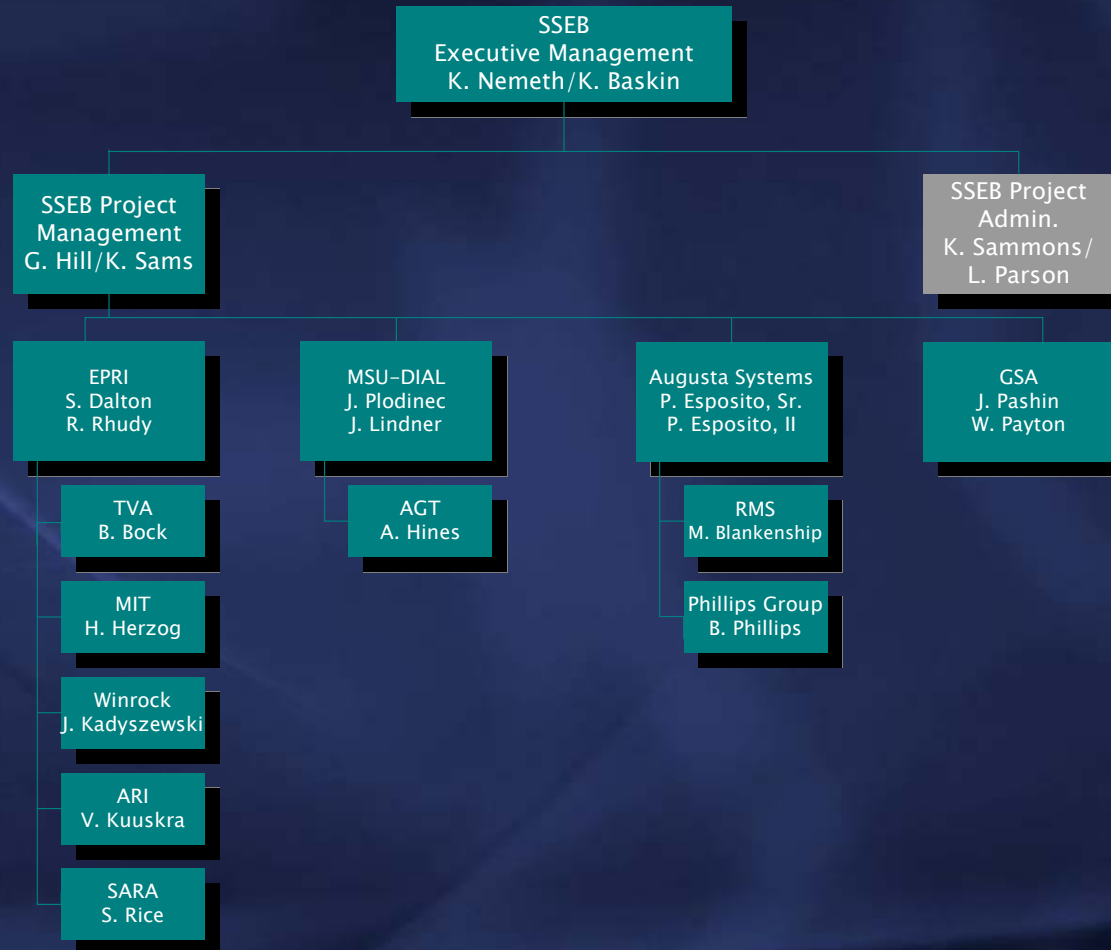
Project Management & Administration



Internal Communications-Project Administration



Internal Communications-Project Management



Partnership Objectives

- Describe partnership sources, sinks and transport requirements
- Develop an outreach plan and engage stakeholders
- Assess environmental risk and develop measuring, monitoring and verification protocols
- Conduct permitting and regulatory review
- Evaluate the life-cycle of storage options
- Prepare action plans for implementation



Areas of Investigation

- Sources/Sinks
- Capture Options
- Terrestrial Sequestration
- Geological Sequestration
- Transportation Infrastructure
- Commercial Use
- Technology Deployment
- Public Involvement, Education and Acceptance
- Regulatory, Permitting and Accounting Frameworks



Task 1:

Define Geographic Boundaries of the Region

- Lead: SSEB
- Support: EPRI, MSU-DIAL, Augusta Systems
- Milestones
 - Inventory major sources and potential sinks
 - Permitting Structure by State
 - Identifying Potential Partners



Task 2:

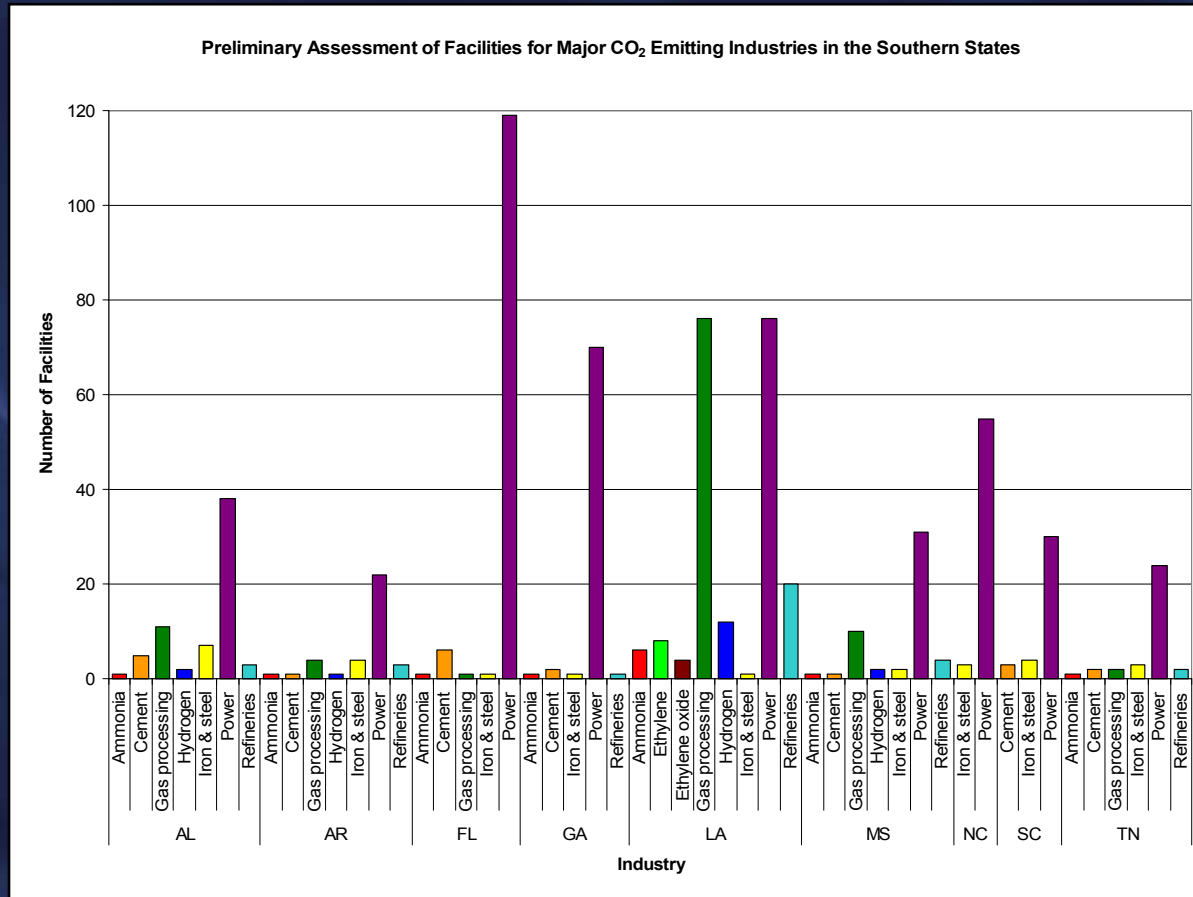
Characterize the Region

- Lead: EPRI
- Support: MSU-DIAL, MIT, TVA-PPI, Winrock, Augusta Systems, Applied Geo Technologies, Geologic Survey of Alabama, Advanced Resources International
- Milestones
 - Preliminary assessment of sources
 - Preliminary assessment of storage options
 - Preliminary assessment transport/infrastructure, separation/purification capacity and CO₂ Use



Task 2:

Characterize the Region



Task 2:

Characterize the Region

- Variety of CO₂ emitting industries (power plants are most common in the Southeast)
 - Focus study on power plant locations and emission estimates, along with proximity of transport infrastructure and potential CO₂ sinks
 - Ammonia plants (located primarily in Louisiana) will be closely assessed due to the purity of their CO₂ streams
- Geologic sequestration opportunities
 - sedimentary rock deposited into shallow non-marine and deep marine environments



Task 2:

Characterize the Region

- Terrestrial sequestration opportunities
 - Agricultural land, grazing land and forestland
- Transportation infrastructure
 - Existing functioning CO₂ infrastructure (pipelines and other transportation infrastructure), separation and purification capabilities and a network of equipment suppliers



Task 3:

Identify and Address Issues for Technology Deployment

- Lead: SSEB
- Support: EPRI, MSU-DIAL, Winrock, Augusta Systems, Susan Rice and Associates, The Phillips Group, RMS Research
- Milestones
 - Preliminary Assessment and Action Plan for:
 - Safety, regulatory and permitting requirements
 - Overcoming public perception issues
 - Ecosystem impacts
 - Monitoring and verification



Task 4:

Development Public Involvement and Education

- Lead: SSEB
- Support: Augusta Systems, The Phillips Group, RMS Research
- Milestones
 - Preliminary public involvement and education mechanisms
 - Test, refine and implement



Task 5:

Identify Most Promising Capture, Storage and Transport Options

- Lead: EPRI
- Support: MSU-DIAL, MIT, TVA-PPI, Winrock, Augusta Systems, Geological Survey of Alabama, Advanced Resources International
- Milestones
 - Summary and promising capture options
 - Summary and promising transportation options
 - Summary and promising storage options
 - Maps linking sources to potential commercial users



Task 6:

Prepare Plans for Technology Validation Activity

- Lead: SSEB
- Support: All Technical Team Members
- Milestones
 - Action Plan and Implementation for
 - Capture options
 - Transportation activity
 - Sequestration options
 - Commercial use
 - Public involvement and education mechanisms
 - Regulatory, permitting and accounting framework
 - integration



Deliverables

- Documentation
 - Results/summaries of findings from assessments
 - Action Plans
 - Report of specific activities as identified in the detailed scope of work for each task
- Computer Products
 - Quarterly Partnership updates
 - Participant list updates
 - Topical Report



External Lines of Communication

- Attend annual NETL Regional Carbon Sequestration Partnership Conferences, 2004-2005
- Attend semi-annual contract review meetings
- Prepare quarterly Technical Team meetings and frequent conference calls
- Develop and maintain a "Southeast Regional Carbon Sequestration Partnership" website
- Disseminate project results to DOE and stakeholders in the region

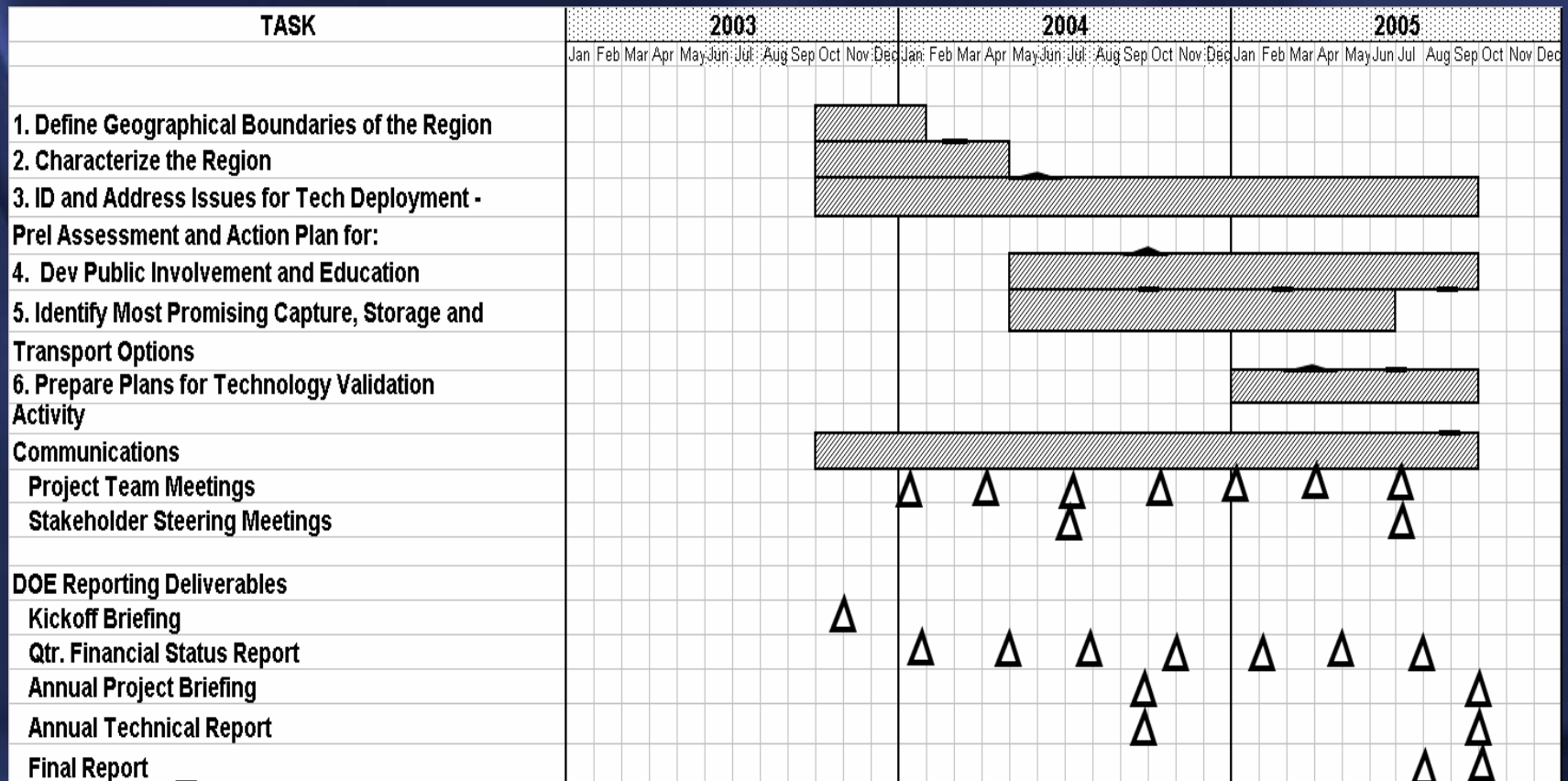


External Lines of Communication

- Communicate/collaborate with other interested parties inside and outside the region to execute an effective outreach program
 - All Regional Carbon Sequestration Partnerships
 - Federal, state, local and tribal governments
 - Technology developers
 - Industry partners
 - Community organizations



Schedule of Project Milestones



Potential Issues and Obstacles and Methods for Mitigation

- Availability of financial resources could limit the extent of investigation that could be performed
 - The Partnership will apply its financial resources to the most promising options identified
- Carbon sequestration issue poses significant communication and education challenges
 - Formalized public opinion and issues research efforts will allow the Partnership to confidently identify specific attitudes and opinions
 - Technical Team expertise in these areas will enable the Partnership to accurately predict some important awaiting challenges



Potential Issues and Obstacles and Methods for Mitigation

- Barriers to the implementation of the most promising options could require extensive changes to regulatory and permitting requirements
 - Members of the Technical Team have extensive experience in addressing such issues with regulatory agencies and with state legislative bodies



Anticipated Impact

- Carbon sequestration is vital for continued use of coal and natural gas, which are vital to the economy in the SSEB region.
- Carbon sequestration will be vital to the future prosperity of the SSEB region.
- The Partnership's work will educate stakeholders on the value of carbon management and carbon sequestration.



Next Steps

Southeast Regional Carbon Sequestration Partnership

- The Partnership will work to support the efforts of President George W. Bush and his team to research, develop and demonstrate cost-effective carbon sequestration technologies.
- The Partnership will encourage and foster active participation among its regional industries, governments, research entities and other enterprises.



Southern States Energy Board

Southeast Regional Carbon Sequestration Partnership

Project Overview
DE-PS26-O3NT41980

Kenneth J. Nemeth
Executive Director
Southern States Energy Board
November 3, 2003
Pittsburgh, Pennsylvania



www.sseb.org



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Southwest Regional Partnership for Carbon Sequestration

Project Overview

DE-PS26-O3NT41983

November 3, 2003

Brian McPherson

New Mexico Institute of Mining and Technology

National Energy Technology Laboratory



Outline

- **Who are the Southwest Partners?**
- **Description of the Southwest Region**
- **Main themes of the Southwest Partnership**
- **Organization and approach**
 - Working groups
 - Management
- **Deliverables, Timeline, Summary**



States in the Southwest Region

Region Covered:

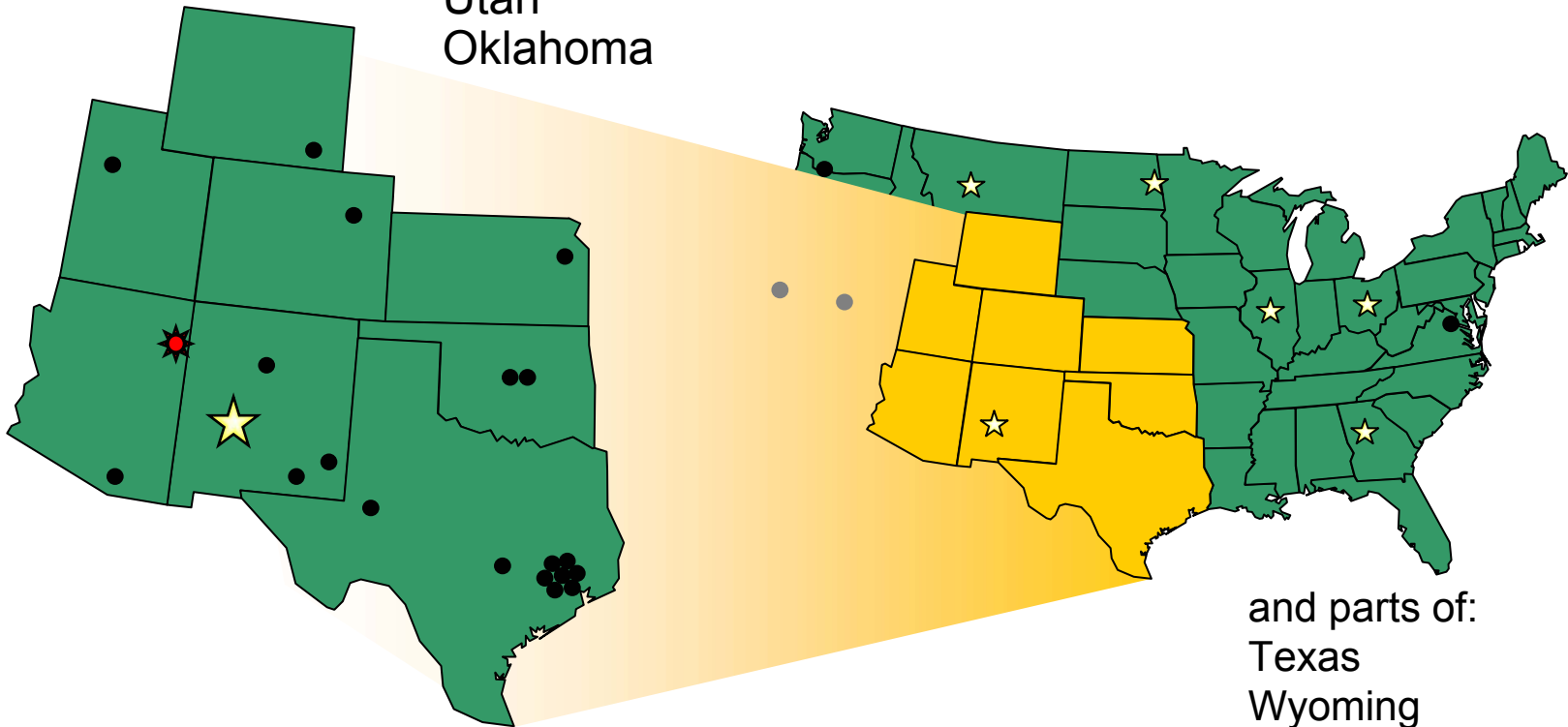
New Mexico

Colorado

Arizona

Utah

Oklahoma



and parts of:

Texas

Wyoming

Nevada

Kansas

Partners in the Southwest Regional Partnership

State Partners

Arizona Universities & Government

Arizona Geological Survey
Arizona State University

Colorado Universities & Government

Colorado Geological Survey
Colorado State University

New Mexico Universities & Government

New Mexico Oil Cons. Division
New Mex. Bureau of Geology
New Mexico Envir. Department
NM Inst. of Mining and Technology
New Mexico State University
Dine College (Navajo Nation)

Oklahoma Universities & Government

Oklahoma Geological Survey
University of Oklahoma
Oklahoma State University
Sarkey's Energy Center

Utah Universities & Government

Utah Geological Survey
University of Utah
Utah State University
Utah AGRC
Utah Division of Air Quality
Utah Energy Office
Utah Division of Oil Gas & Mining

Industry Partners

Power utilities:

Public Service Co. of New Mexico (PNM)
PacifiCorp

Intermountain Power Agency

Tucson Electric Power

Oklahoma Gas & Electric

Energy providers (oil, gas, coal):

Yates Petroleum, ChevronTexaco

Marathon, Occidental Permian

ConocoPhillips, Burlington

Gas infrastructure (CO₂ pipelines):

Kinder Morgan

U.S. Federal Government Partners

Los Alamos National Laboratory

Sandia National Laboratory

U.S. Dept. of Agriculture

Various Additional Partners

Navajo Nation

New Mexico Oil and Gas Association

Gas Technology Institute (GTI)

Electric Power Research Institute (EPRI)

IOGCC

CEED

Advance Resources International (ARI)

Western Governors Association

Petroleum Recovery Research Center (PRRC)

Waste-management Educ. & Res. (WERC)



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Description of the Southwest Region

Sources:

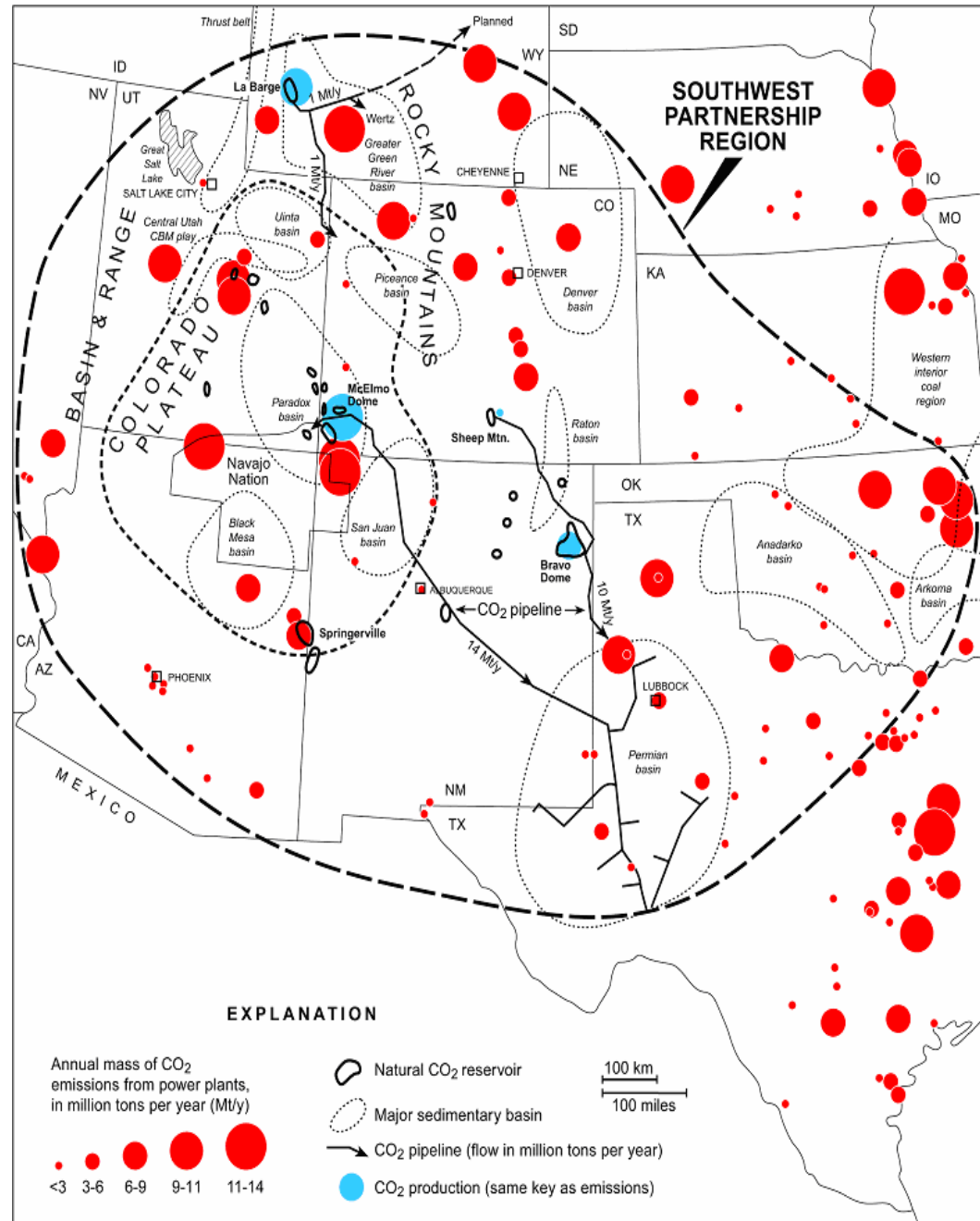
- electrical power plants
- cement and other processing plants
- urban centers
- non-point sources (agriculture, automobiles, etc.)

Sinks

- geologic (oil/gas reservoirs, deep saline aquifers, coalbeds, natural CO₂ reservoirs, etc.)
- terrestrial (agriculture, forests, etc.)
- mineralization engineering (surface)

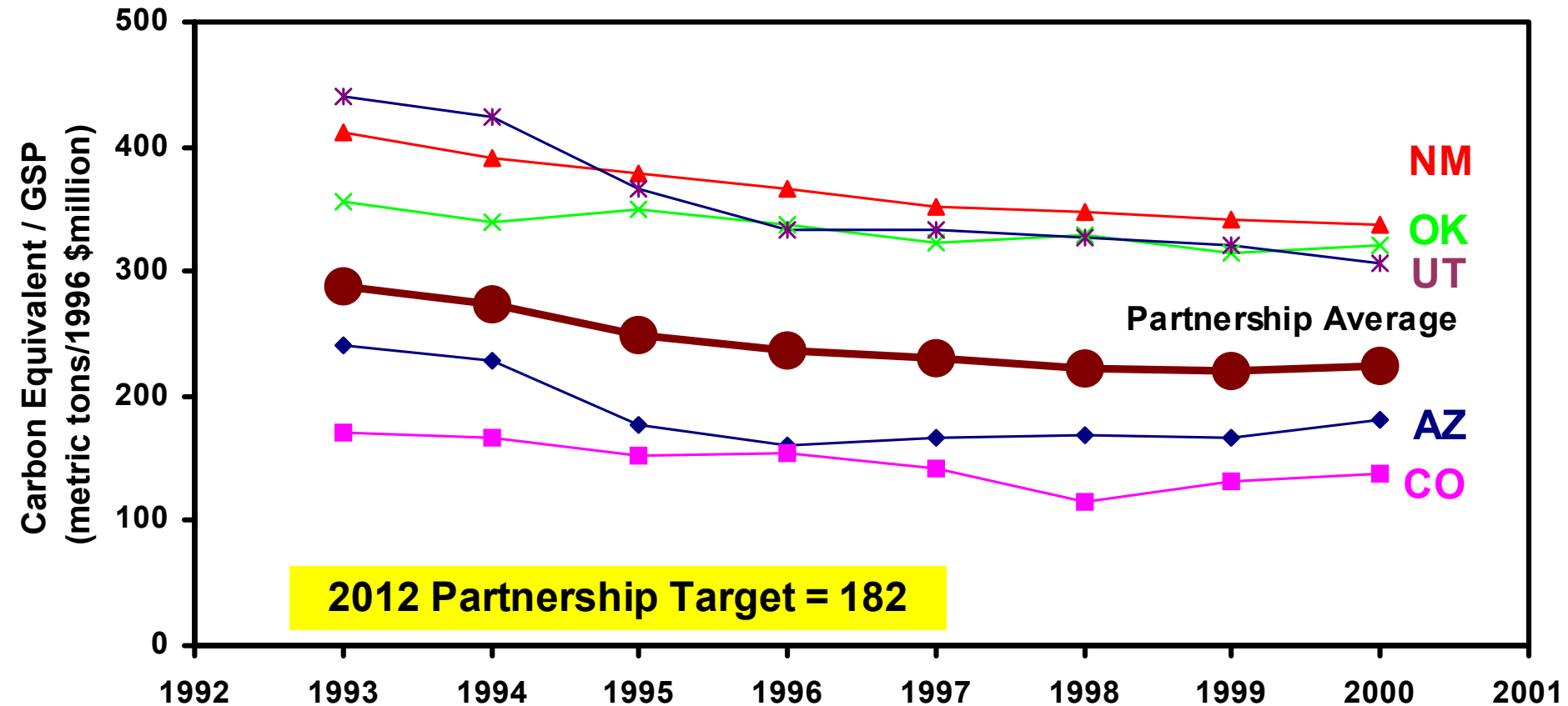
Infrastructure

- Extensive CO₂ pipeline networks



Description of the Southwest Region

Trends in greenhouse gas intensity for the Southwest Region

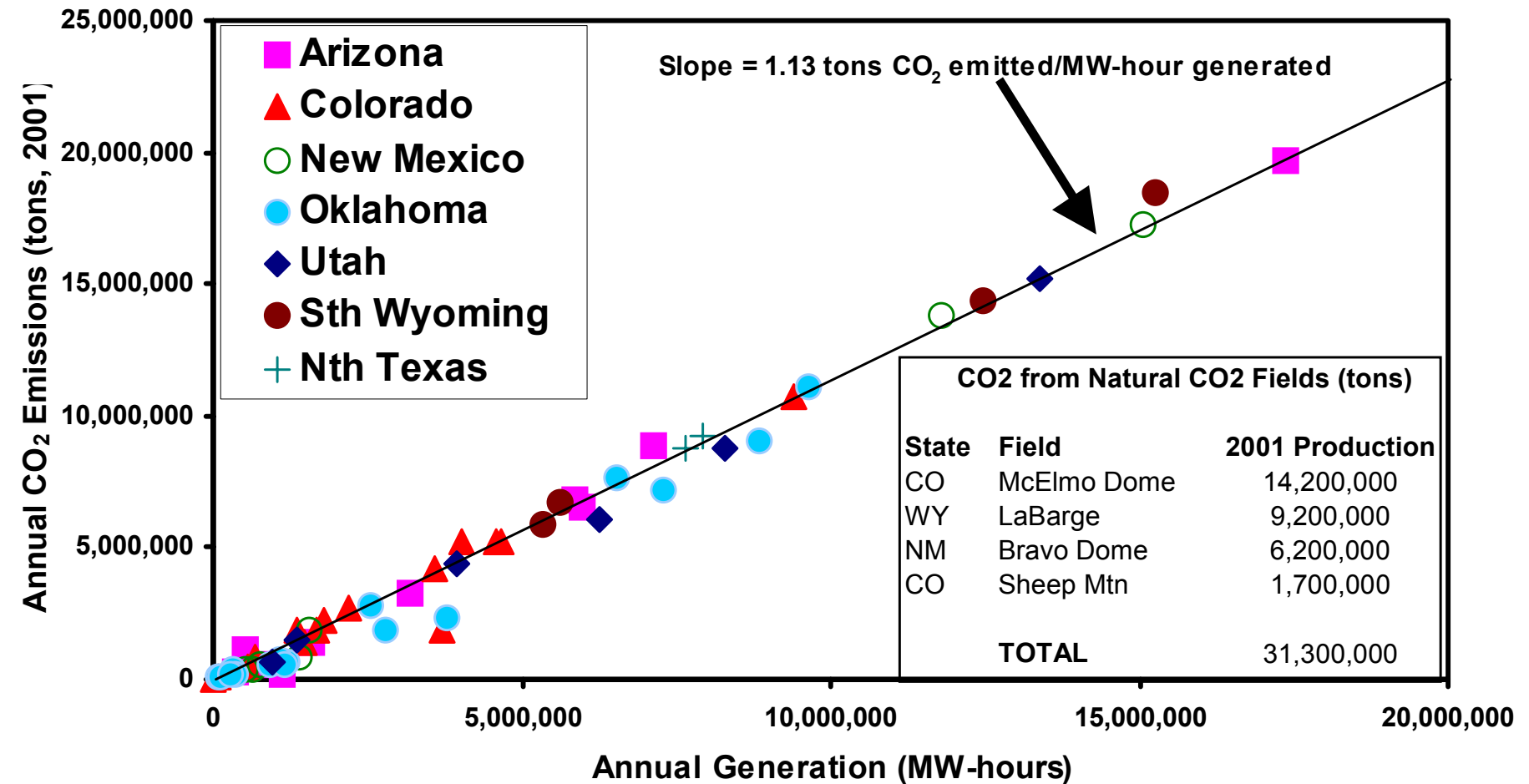


Trends in greenhouse gas intensity (metric tons carbon equivalent/million gross state product dollars; 1996 chained) for the Southwest Partnership region. The national average in 2002 is 185 (Klara, 2002). This region is above average because it is rich in fossil fuels. Between 1993 and 2000, the regional average carbon equivalent/gross state product declined 22%, largely because of rapid economic growth



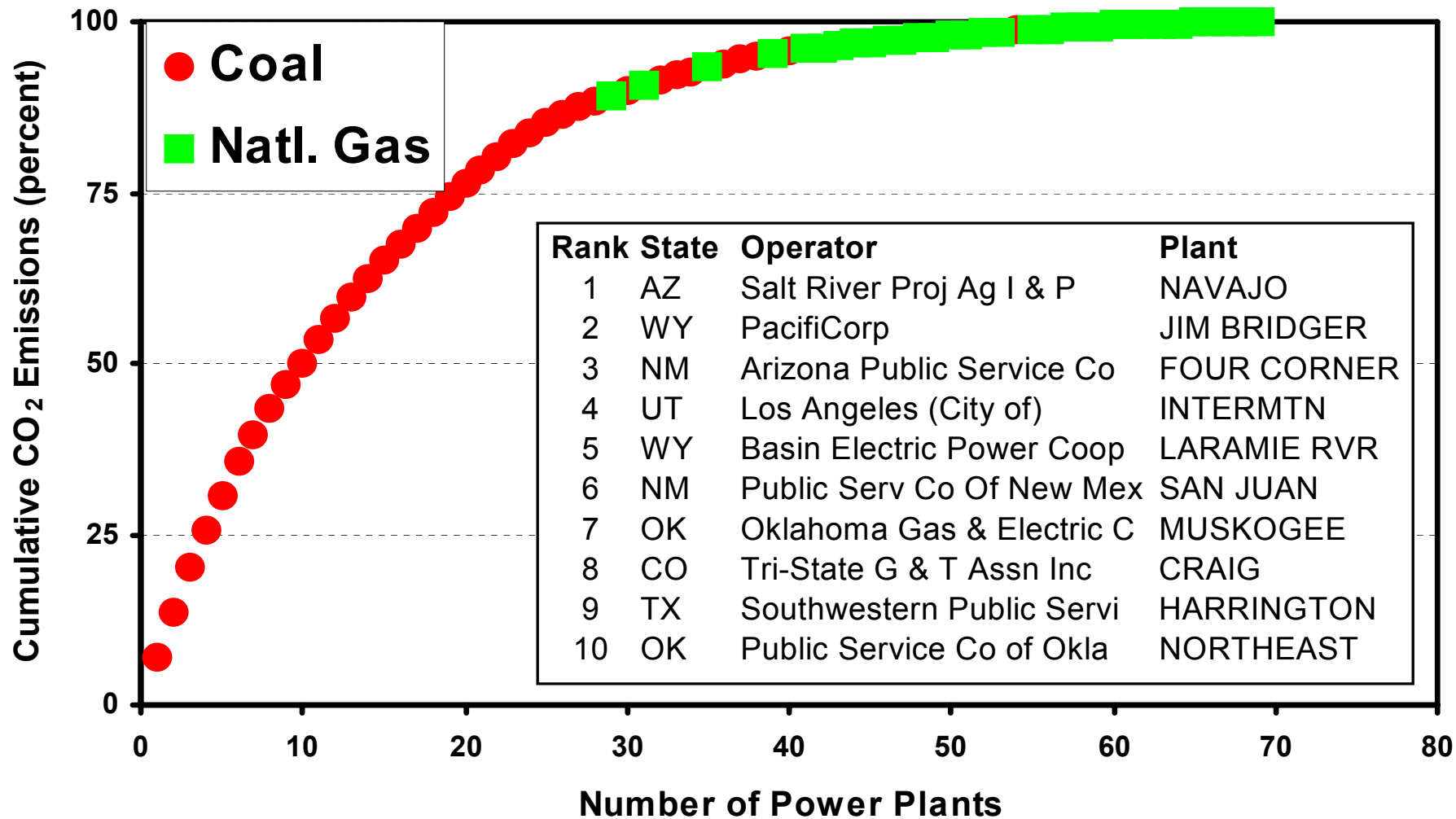
Description of the Southwest Region

CO₂ Emissions proportional to amount of electricity generated



Description of the Southwest Region

10 largest power plants in region contribute 50% of emissions!



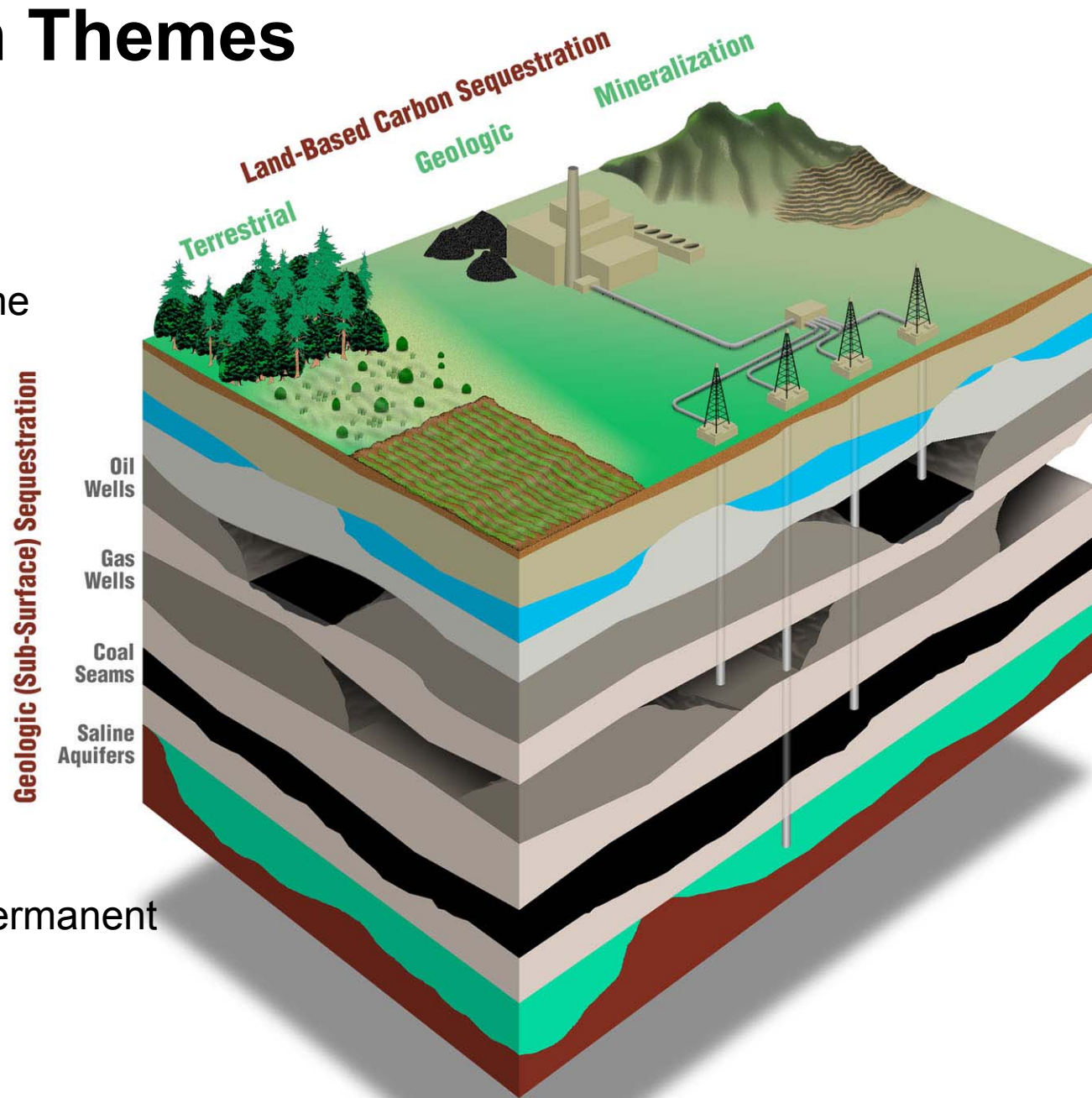
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Sequestration Themes

- Geologic systems
 - Potentially large volume
- Terrestrial systems
 - Rapid implementation
- Mineralization
 - High uncertainty but permanent
 - Very large volume
 - safety / risks known

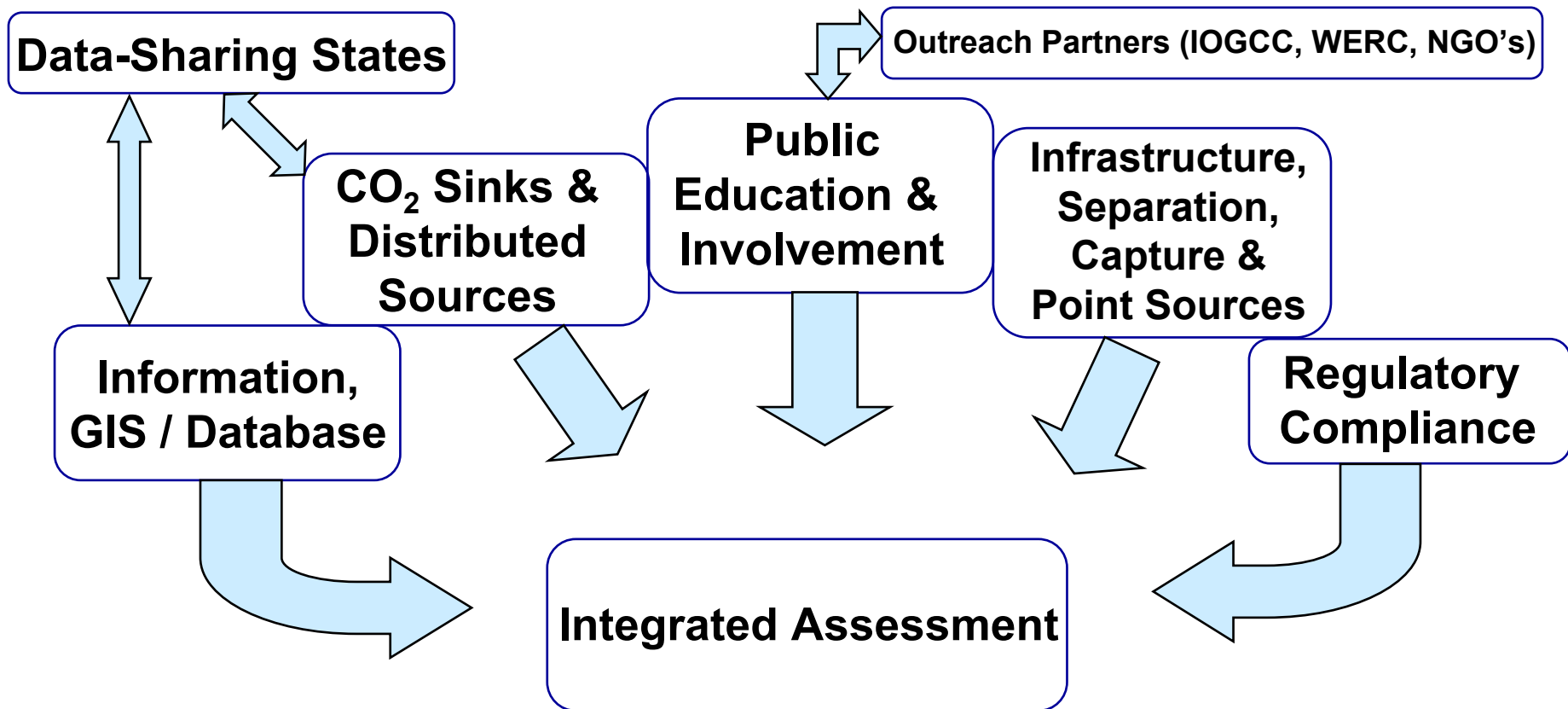


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Working Groups



Information, GIS / Database Committee

Coordinator: Dennis Goreham (Utah AGRC)

- will design and maintain a Southwest regional information database (GIS-based)
- database will be used for analysis and to support a proposed integrated assessment model
- data will be accessible / downloadable through a public website
- core-data attributes that maximize portability and applicability will be established
- western states' database and/or national database is ultimate goal



CO₂ Sinks & Distributed Sources Committee

Coordinators: Richard Hughes (University of Oklahoma)
with George Guthrie (LANL), Gill Bond (NMIMT), John Stringer (EPRI) - Mineralization
Rajesh Pawar (LANL), Bill Raatz (NMIMT), Rick Allis (UGS) – Geologic
Joel Brown (USDA), Jerry Stuth (Texas A&M) – Terrestrial

- will summarize distributed CO₂ sources in the region
- will evaluate terrestrial carbon capacity
- will describe geological and mineralization sink options
- will summarize sequestration technologies available in the region
- will provide data directly to database and integrated assessment teams
- will summarize risk-factor framework



- will summarize monitoring and verification protocols

Public Education and Involvement Committee

Coordinators: Dave Curtiss and Tarla Peterson (University of Utah)

- Responsible for communicating with stakeholders, i.e., project partners, industry, NGOs, federal, state, and local policy makers, as well as the general public
- will organize and facilitate focus groups to determine public perceptions of potential risks associated with CO₂ sequestration
- facilitate three (3) mediated-modeling workshops with stakeholders
- host town hall meetings
- will create information packets for the public (mail, etc.)
- develop a handbook for identifying / implementing specific strategies
- assist in website design and implementation



Infrastructure, Separation and Capture Committee

Coordinators: Dennis Leppin (GTI) and Mike Hirl (Kinder Morgan)

- responsible for identifying and cataloguing point sources of CO₂ (e.g., power plants, cement plants, etc.)
- will assess and summarize current separation and capture technologies employed in the region
- will summarize information about costs and methods currently employed for sequestration, separation, and capture technologies
- will summarize transportation infrastructure and possible future transportation needs



Regulatory Compliance Committee

Coordinator: Lori Wrotenbery (New Mexico Oil Conservation Division)

- will summarize current state and federal regulations associated with all possible CO₂ sequestration approaches
- leverage current knowledge associated with CO₂ – EOR regulatory framework
- will outline differences in regulations, identify gaps or uncertainties, and develop a database of regulatory information and issues for implementation in the integrated assessment model



Integrated Assessment Committee

Coordinator: Orman Paananen (Sandia National Laboratories)

- will develop a dynamic systems model using data gathered from other working groups
- model will quantitatively compare CO₂ sequestration technologies and qualitatively compare options for policy decision-makers
- committee will specifically create alternative “What if?” scenarios based on efficiencies, costs, etc., and rankings will be assessed
- model resolution will be tailored to reflect information available in database (optimization)
- model will be used to assess future transportation needs

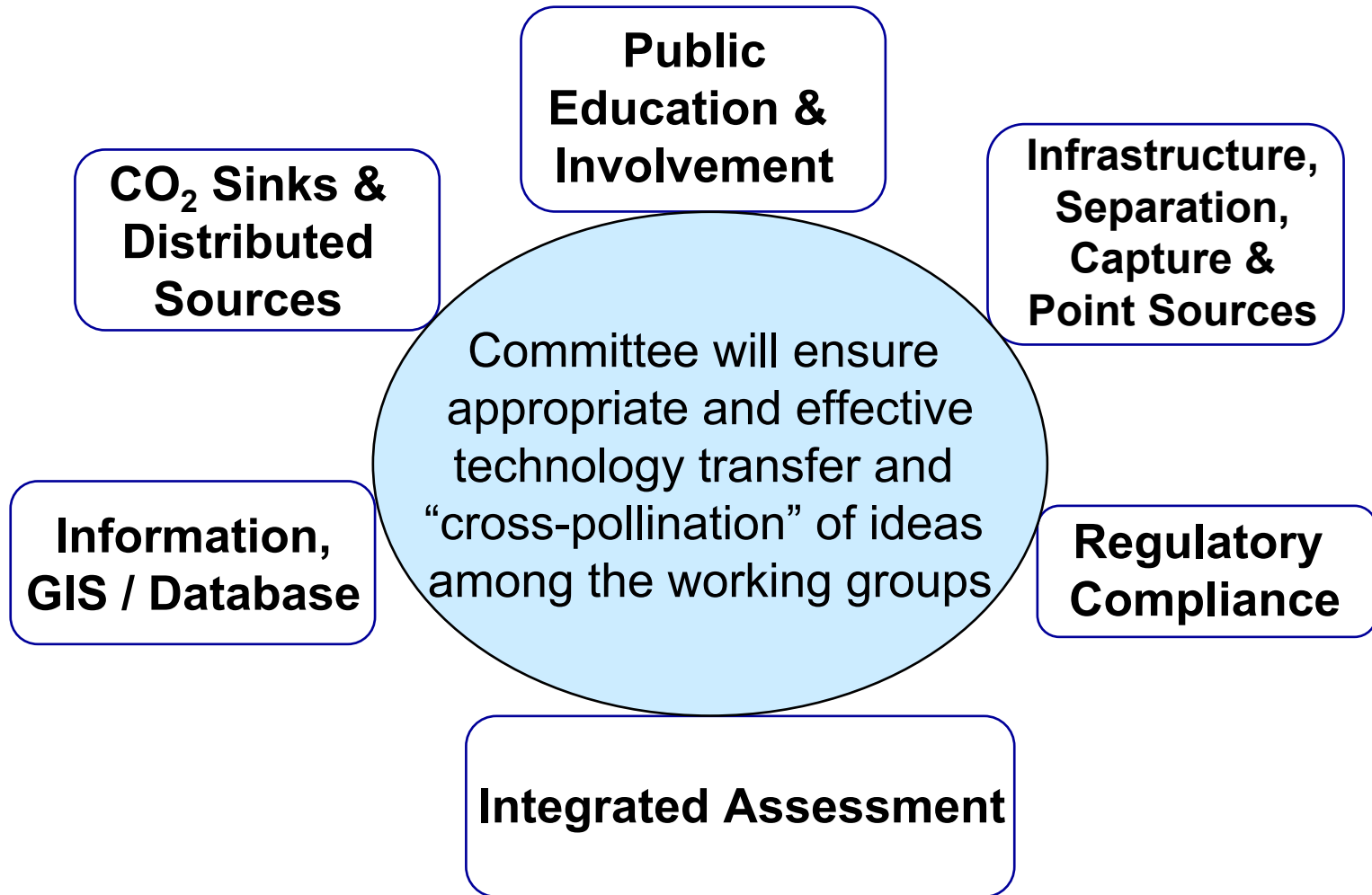


Outline

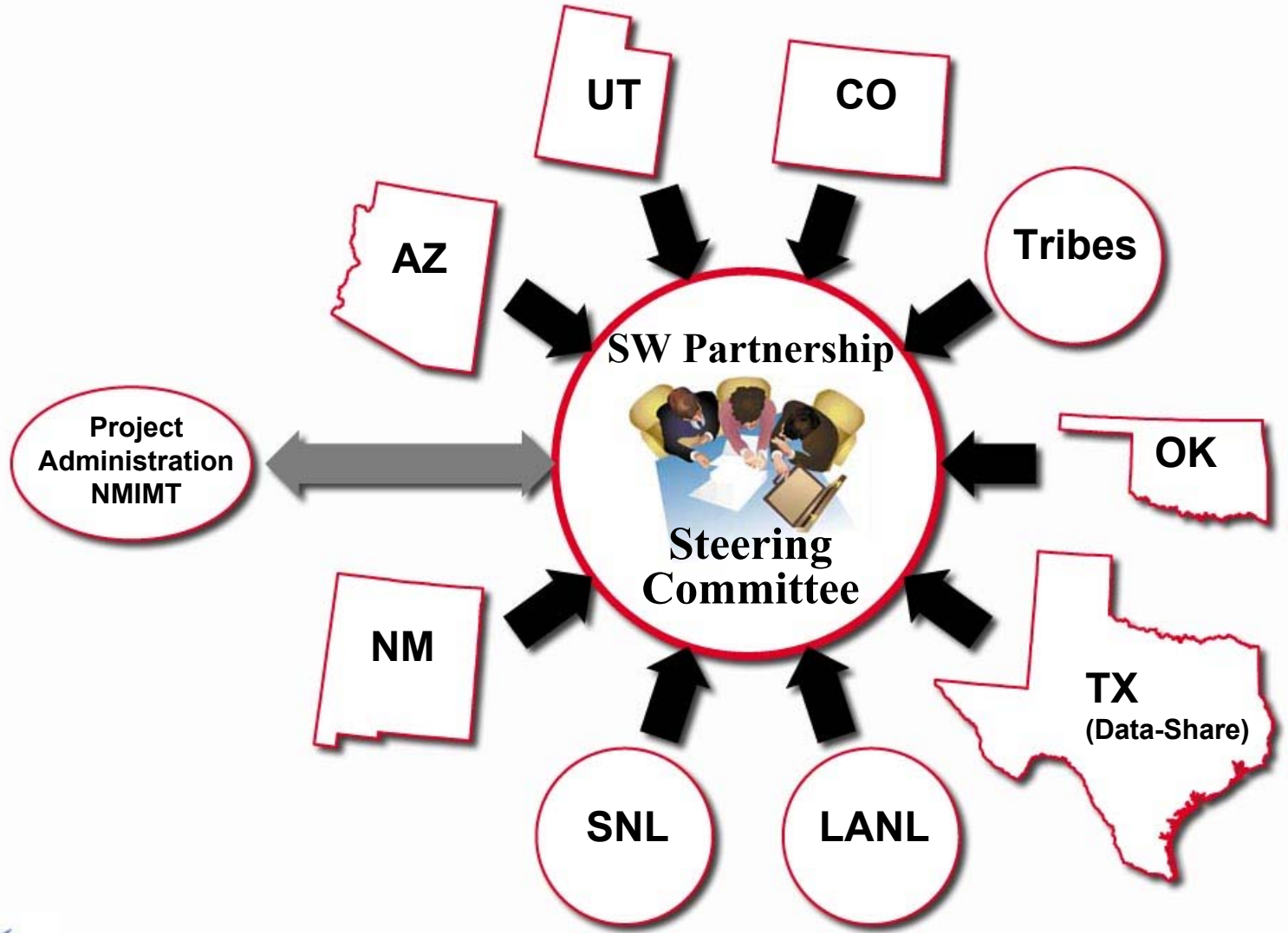
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Committee of Working Group Coordinators



Executive Steering Committee



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Summary of Major Goals

Goal 1: Characterize the Southwest Region

Goal 2: Assess and Initiate Public Outreach and Acceptance

Goal 3: Identify and Address Implementation Issues for Phase II

Goal 4: Identify and Rank Sequestration Options for the Southwest Region



Draft Timeline Table for Deliverables

Working Group	1st Qtr Oct – Dec	2nd Qtr Jan – Mar	3rd Qtr Apr - Jun	4th Qtr Jul - Sep	5th Qtr Oct – Dec	6th Qtr Jan – Mar	7th Qtr Apr – Jun	8th Qtr Jul – Sep
Sinks and Distributed Sources	-Data scale, standards, type -Minimum data required for model		- CO ₂ source data assembled	- CO ₂ sink data assembled				Final Reporting
Infra/Sep/Cap/Point Sources	-Data scale, standards, type -Minimum data required for model		- CO ₂ source data assembled - Pipeline information assembled		- Separation and capture data assembled			Final Reporting
Regulatory Compliance	-Data scale, standards, type	-Baseline regulatory framework assembled	-Preliminary analysis of differences, gaps and uncertainties			Regulatory Analysis completed		Final Reporting
Public Involvement	- workshop content defined - workshop invitations sent - website content designed	-Workshop #1 (public view of end states) -Public Website implemented	-Workshop #2	-Townhall meetings scheduled and materials developed -1 st draft of info packet circulated to all TCs	-Info packets revised -Final draft of info packet completed	-Workshop #3	- Mediated modeling completed	Final Reporting
Information, GIS / Database	-Data scale, standards, type -Minimum data required for model	-Team GIS database implemented	-Draft public GIS database implemented		-Public GIS database implemented		- Public GIS database completed	Final Reporting
Integrated Assessment	-Data scale, standards -Minimum data requirements reported	- Regionalize model	-Model implemented - CO ₂ source data assembled		-All data and protocols implemented in model	- Model finalized	- Sequestration technologies evaluated and ranked	Final Reporting
All Working Groups	Team website implemented				-Risk factors assigned	-Gap analysis of monitoring and verification protocols completed		Final Reporting
All Working Groups					- Draft Phase II Action plan completed	- Phase II Action plan completed		Final Reporting



Some “take home” points:

- The Southwest Partnership sequestration strategy is projected to meet desirable GHG-intensity reduction goals prior to 2012
- The Southwest Region has natural attributes that suggests an optimum sequestration strategy that accounts for
 - existing infrastructure
 - experience handling, emplacing, and living with underground CO₂ (esp. via EOR)
 - regional water limitations in the south
- The Partnership will use a comprehensive integrated assessment strategy as well as a novel outreach approach

Southwest Representatives in Attendance

(Breakout Session Participants)

- **George Guthrie (LANL)**
- **Dennis Goreham (Utah AGRC)**
- **Dave Curtiss (University of Utah EGI)**
- **Howard Meyer (GTI)**
- **Susan Hovorka (Texas BEG)**



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Northern Rockies and Great Plains Regional Carbon Sequestration Partnership:

**Montana State University-Bozeman
Boise State University
South Dakota School of Mines and Technology
Texas A&M University
University of Idaho**

**Idaho National Engineering and Environmental Laboratory
Los Alamos National Laboratory**

**EnTech Strategies and New Directions
National Carbon Offset Coalition**

**Inland Northwest Regional Alliance
State of Montana, Governor's Office
Nez Perce Tribe
The Confederated Salish and Kootenai Tribes
Energy companies and other coalitions**



DOE Regional Carbon Sequestration Partnership Meeting

Hyatt Regency, Pittsburgh Airport

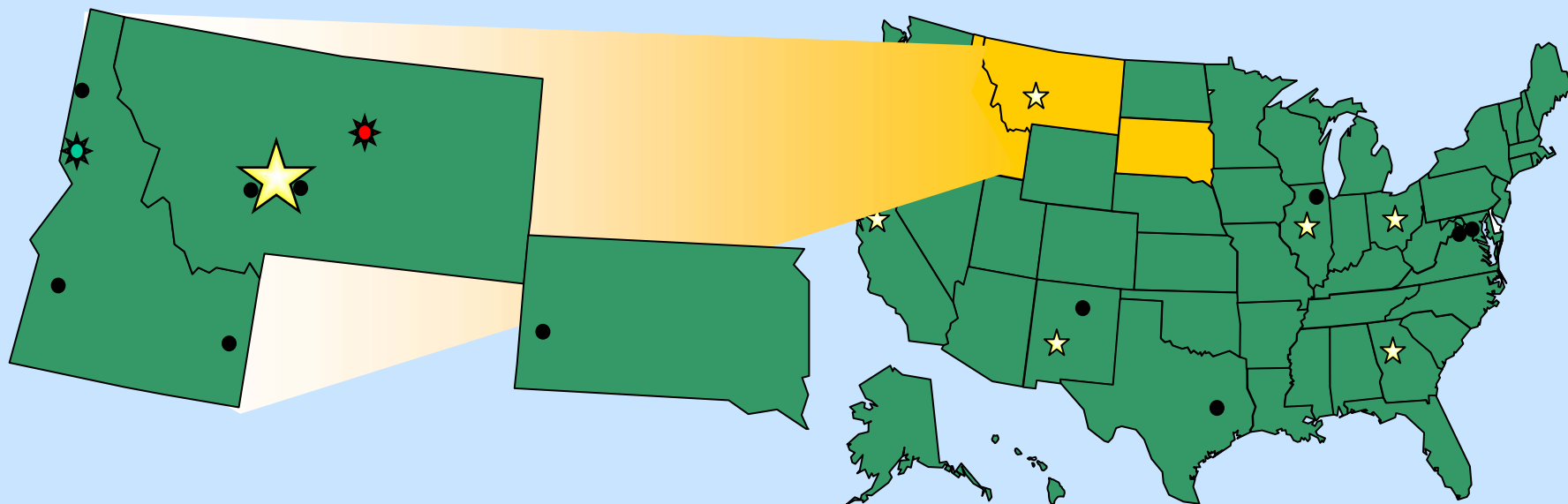
November 3-4, 2003

Dr. Susan M. Capalbo

scapalbo@montana.edu

www.climate.montana.edu

Northern Rockies & Great Plains Carbon Sequestration Partnership



Region Covered:

Montana
Idaho
South Dakota

Partners:

- ★ Montana State University
- Boise State University
- South Dakota School of Mines and Technology
- Texas A&M
- University of Idaho
- The Sampson Group
- New Directions NALLC
- Environmental Financial Products
-

- ★ Nez Perce Tribe
- ★ The Confederated Salish and Kootenai Tribes
- Idaho National Engineering and Environmental Laboratory
- Los Alamos National Laboratory
- Montana Governor's Carbon Sequestration Working Group
- National Carbon Offset Coalition
-

Partnership Objectives

Provide *coordinated* disciplinary-based research, policy analysis, and outreach that focuses on mitigating GHG buildup through carbon sequestration alternatives

The Partnership will:

- 1) identify and catalogue sources of CO₂ and promising geologic and terrestrial storage sites;**
- 2) develop a risk assessment and decision support framework to optimize the region's carbon storage;**
- 3) enhance market-based, voluntary approaches to carbon storage;**
- 4) identify and apply advanced GHG measurement technologies to improve verification protocols, support voluntary trading and stimulate economic development;**
- 5) engage community leaders to define carbon sequestration implementation strategies and**
- 6) create forums to inform and secure input from the public.**

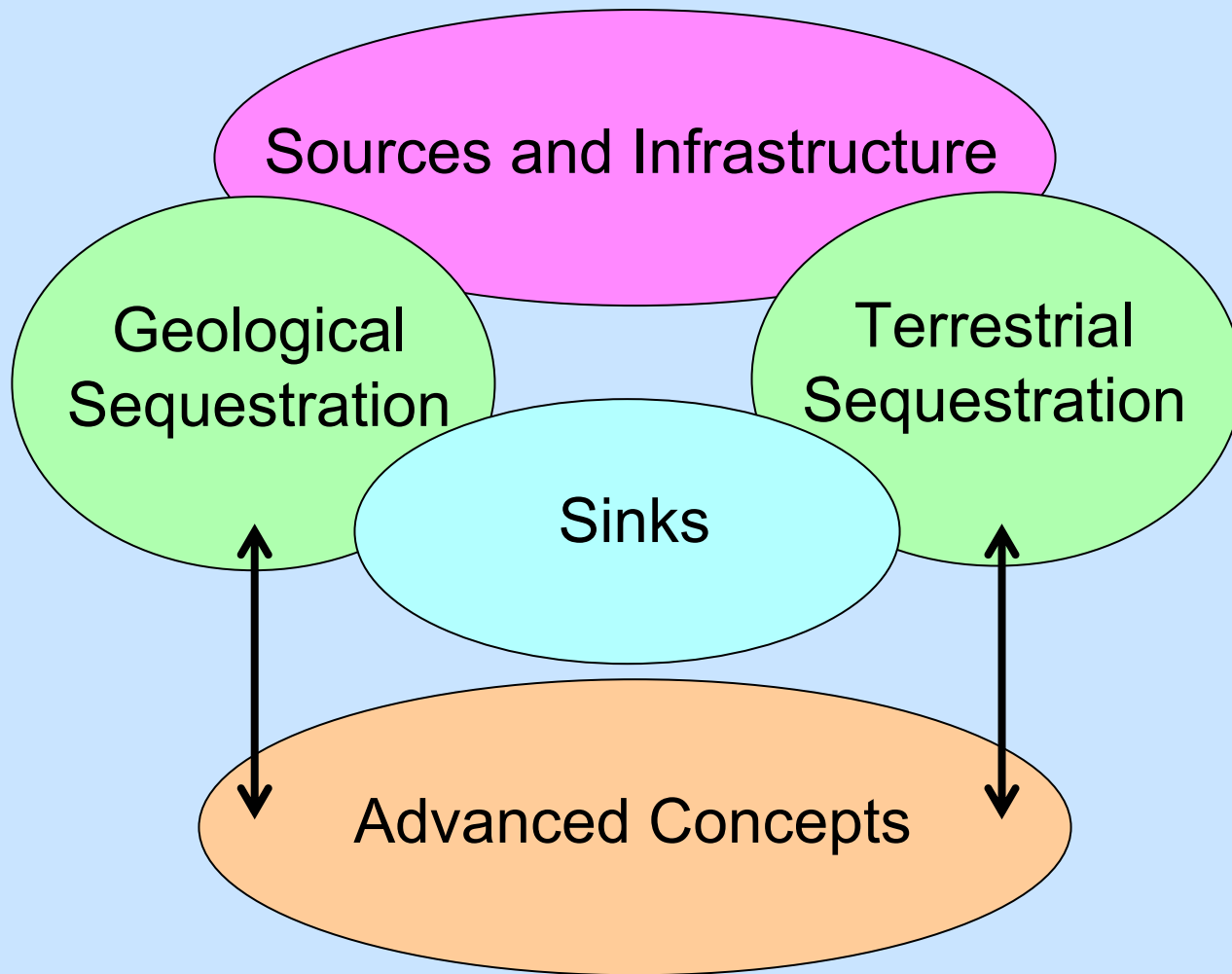
Partnership reflects extensive expertise and experience in carbon sequestration research

- **Engineers, physical/biological scientists, economists, policy analysts, policy leaders, communications specialists**
- **Strong Capabilities in**
 - **GIS systems**
 - **geological sequestration technologies and assessment**
 - **terrestrial sequestration technologies and soil C measurement**
 - **Designing frameworks for understanding economic, environmental, and risk tradeoffs with alternative sequestration sinks**
 - **Market-based trading for carbon**
- **Broad understanding and hands-on experience with technical, economic, and market issues related to carbon sequestration trading**
- **Strong skills and experience in communications and outreach that uniquely coalesce around carbon sequestration and involves many stakeholders including tribal nations**

Organization of the Partnership

Focus areas:

- **Sources and Infrastructure (GIS based)**
- **Geological Sequestration**
- **Terrestrial Sequestration**
- **Advanced Concepts**
- **Outreach and Education**



Outreach/Communications

Organization of the Partnership (cont)

Leadership team

Susan Capalbo (MSU) PI

John Antle, (MSU) terrestrial sequestration

Dick Benson (LANL) advanced concepts

David Shropshire (INEEL) geological and GIS

Robert Smith (UI) geological sequestration

Pamela Tomski (EnTech) outreach and education

**Patrick Zimmerman (SDSMT) terrestrial
sequestration/GIS**

Steering Committee

includes representation from all collaborators

Sources and Infrastructure

- **Characterize the region relative to sources and transportation infrastructure**
- **Industrial and agricultural sources**
Fossil fuel power plants, industrial plants, agricultural sources (feedlots)
- **Look at all three major GHGs**
- **Archive the information in a GIS database**

Coordinated effort: INEEL, LANL, SDSMT, MSU

Geologic Sequestration

Understand the behavior of CO₂ when stored in geological formations

Provide information on the potential magnitude/location of the geological sinks in the region

- ***University of Idaho***
 - ***Bob Smith (technical coordinator)***
- ***Boise State University***
 - ***Warren Barrash***
 - ***Bill Clement***
- ***Idaho National Engineering and Environmental Laboratory***
 - ***David Shropshire (program coordinator)***
 - ***Randy Lee***
 - ***Travis McLing***
- ***Los Alamos National Laboratory***
 - ***Rajesh Pawar***

Geologic Sequestration

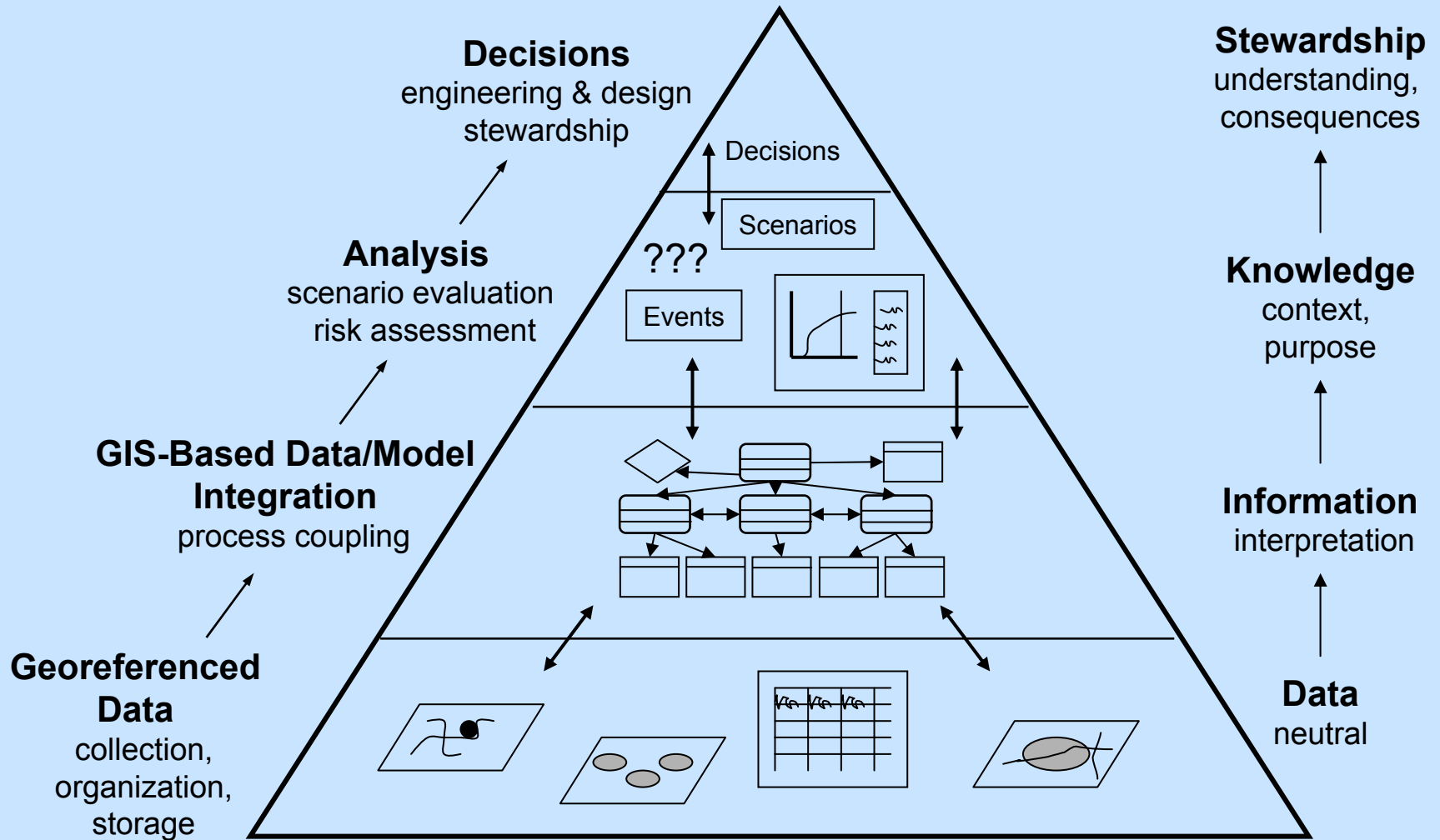
TASK 1: Development of GIS database structure

OBJECTIVE: Define and implement a standardized approach for storing geographic technical, infrastructure, and economic information

- **Design GIS Database**
 - **Establish list of contributors and their needs**
 - **Define end users and their requirements**
 - **Design system to be scalable for needs of Phase II and beyond**
 - **Establish common protocols (e.g., datum, terminology, data fields, metadata standards, etc.)**
 - **Define the rolls of the GIS groups (e.g., data development, system maintenance, data documentation, etc.)**
- **Build System**
 - **Gather and load existing information**
 - **Provide products that meet the needs of the larger partnership**

LEAD INSTITUTION: INEEL

Spatial Decision Support System



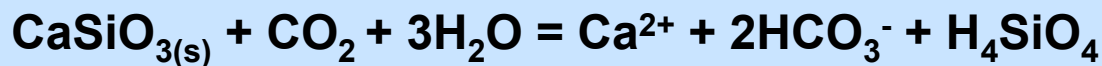
Geologic Sequestration

TASK 2: Assessment of Mineralization Trapping Potential

OBJECTIVE: Define the contribution of reservoir weathering reactions to the sequestration of CO₂ in regional traps

Mineral Trapping of CO₂ in Geologic Reservoirs

- Characterize the ability of geologic terrain in the study area to facilitate the mineralization of CO₂ into stable mineral phases.
- Weathering of silicates in aquifer host rocks via the following simplified reaction consumes 2 moles of CO₂ for every mole of calcite precipitated.



leads to



LEAD INSTITUTION: INEEL

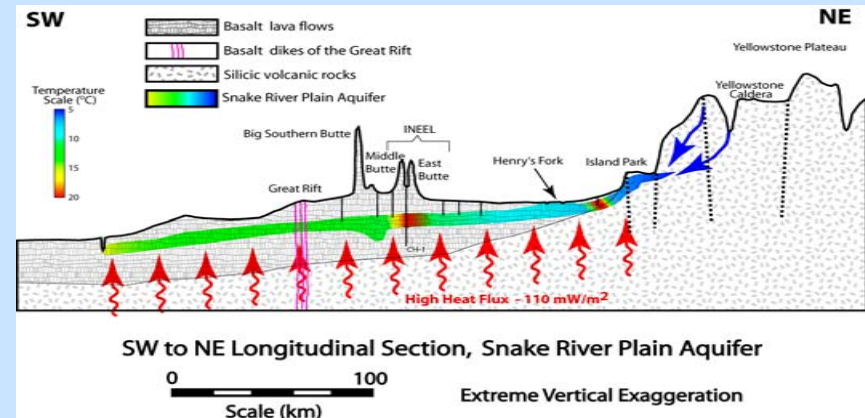
Geologic Sequestration

TASK 3: Assessment of Solubility Trapping Potential

OBJECTIVE: Define the contribution of deep geologic fluids (formation water and hydrocarbons) to the sequestration of CO₂ in regional traps

Solubility Trapping

- Characterize hydrochemical conditions of deep geologic basins in study area.
 - Water chemistry will be extracted from existing databases.
- Model CO₂ uptake potential of deep basin groundwaters using Geochemist Workbench
- Benchmark models with previously conducted laboratory studies.



LEAD INSTITUTION: University of Idaho - Idaho Falls

Geologic Sequestration

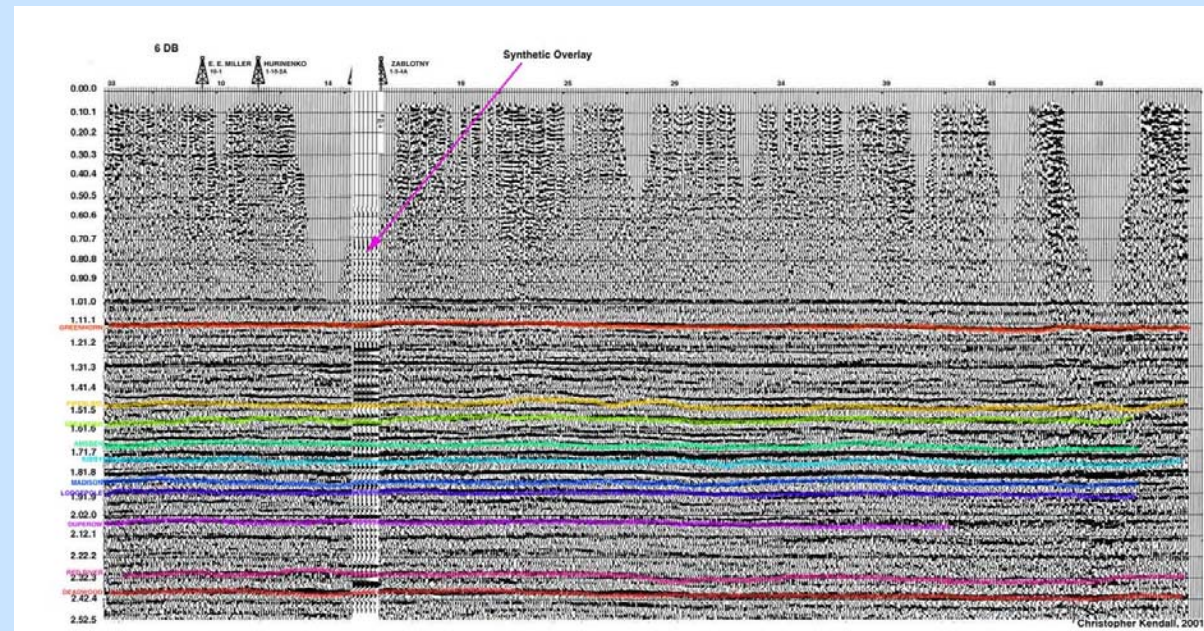
TASK 4: Assessment of Hydrodynamic Trapping Potential

OBJECTIVE: Define the reservoir volumes and containment characteristics of regional traps for the sequestration of CO₂

Assessment of Hydrodynamic Trapping Potential

- **Identify Federal and State inventories**
 - **Seismic reflection data and VSP**
 - **Well logs and core**
 - **Well tests**
- **Analyze data for potential sinks**
 - **Physical properties**
 - **Viability and storage capacity**

LEAD INSTITUTION: Boise State University

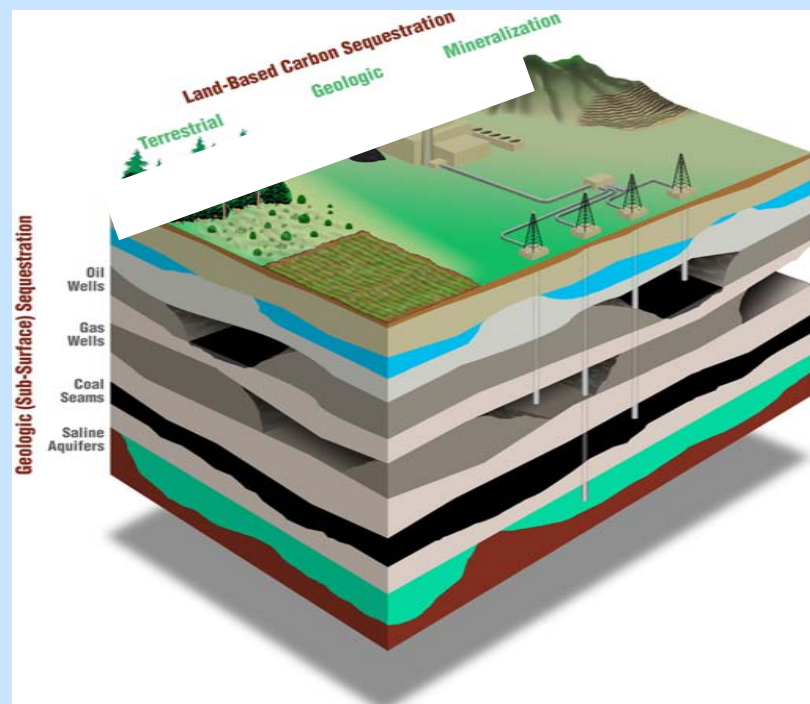


Geologic Sequestration

TASK 5: Assessment of Technical Feasibility and Offsetting Economic Benefits

OBJECTIVE: Define infrastructure requirements, costs, and off setting economic benefit for the sequestration of CO₂ in regional traps

- **Compile Infrastructure Information into GIS Database**
- **Determine Storage Capacity**
 - **Oil/Gas Reservoirs**
 - **Aquifers**
 - **Coalbed Methane Reservoirs**
- **Long-Term Storage Capability**
- **Evaluate Infrastructure Needs and Associated Costs**
- **Determine Sequestration Benefits**
- **Evaluate Geologic Sinks**

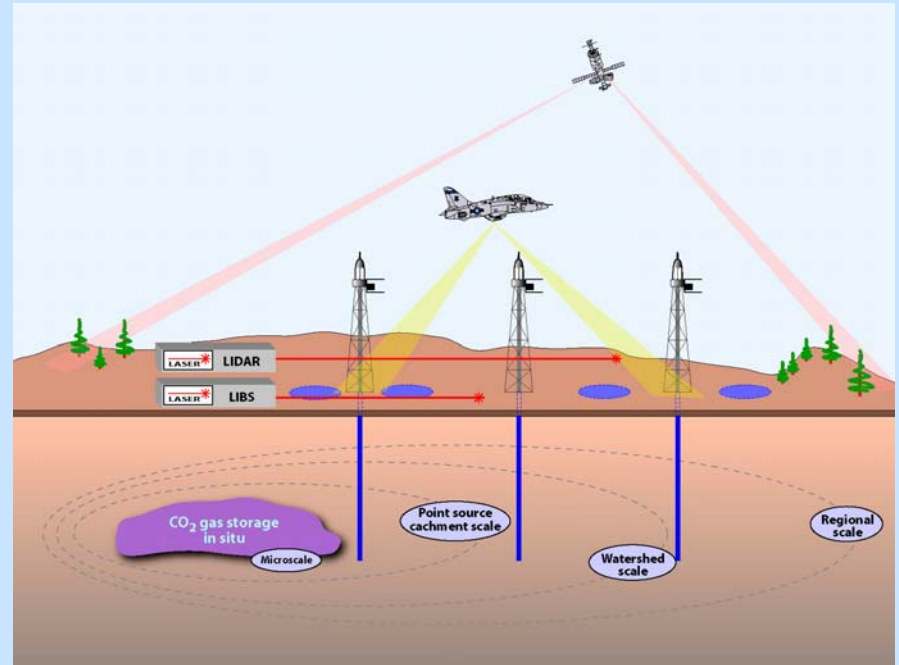


LEAD INSTITUTION: Los Alamos National Laboratory

Integrated MMV Concept

LANL Lead in Measurement, Monitoring and Verification

- Measurement, Monitoring and Verification (MMV)
 - Integrated MMV Diagnostics Assessment
 - Gap Analysis
- MMV of Sequestration
 - Cost Effectiveness
 - Risk Analysis
- MMV Deployment Plan
 - Local Manufacturing and Maintenance



Terrestrial Sequestration

Understand the ecosystem impacts and long term effectiveness

Cost-competitive, economic vs technical potential

Quantification and measurement of soil C

- ***Montana State University***
 - ***Susan Capalbo, John Antle***
 - ***Perry Miller, Rick Engel***
- ***South Dakota School of Mines and Technology***
 - ***Pat Zimmerman, Karen Updegraff, Bill Capehart***
- ***Texas A&M University***
 - ***Jerry Stuth, Jay Angerer***
- ***National Carbon Offset Coalition***
 - ***Ted Dodge***

Ecosystems that offer opportunities for soil C sequestration in the region:

- agricultural lands (croplands, grasslands, range lands)**
- wetlands (management of soil C pools, limit conversion)**
- forested lands and agroforested areas**
- degraded lands**

Where should/would soil C be sequestered?

- soil scientists: *should be* where potential ΔC highest...e.g., on most degraded lands?
- economists: *would be* where $\Delta\pi/\Delta C$ lowest! (opportunity cost)

Key Point: $\Delta\pi$ and ΔC are correlated, so its not obvious where the ratio is lowest, must look at both biophysical and economic factors

Terrestrial Sequestration

TASK 1: Coordinating the GIS database with the geological sequestration efforts

OBJECTIVE: To integrate soil, climate, and management data as well as GHG source data into a single standardized GIS database

TASK 2: Evaluate terrestrial sequestration potential in regional ecosystems and assess long term effectiveness and costs

OBJECTIVE: Examine both the technical and economic potential for soil C sequestration

TASK 3: Assess existing conservation programs for sequestration potential

OBJECTIVE: Examine the connections between existing agricultural policies which affect land use and policies which provide incentives for additional soil C sequestration

TASK 4: Monitoring and measurement

OBJECTIVE: Development of monitoring technologies and verification schemes, needed for carbon emissions trading and other policies

Two frameworks for quantifying soil C sequestration potential:

- C-lock (SDSMT)**
- Integrated biophysical/economic assessment framework (MSU)**

The South Dakota Carbon Sequestration Project



•Funding provided by Governor William Janklow currently serving as the lone U.S. Congressional Representative from South Dakota and the State of South Dakota (BOR) and NSF EPSCoR

--The C-lock program is administered by the Institute of Atmospheric Sciences at SDSMT

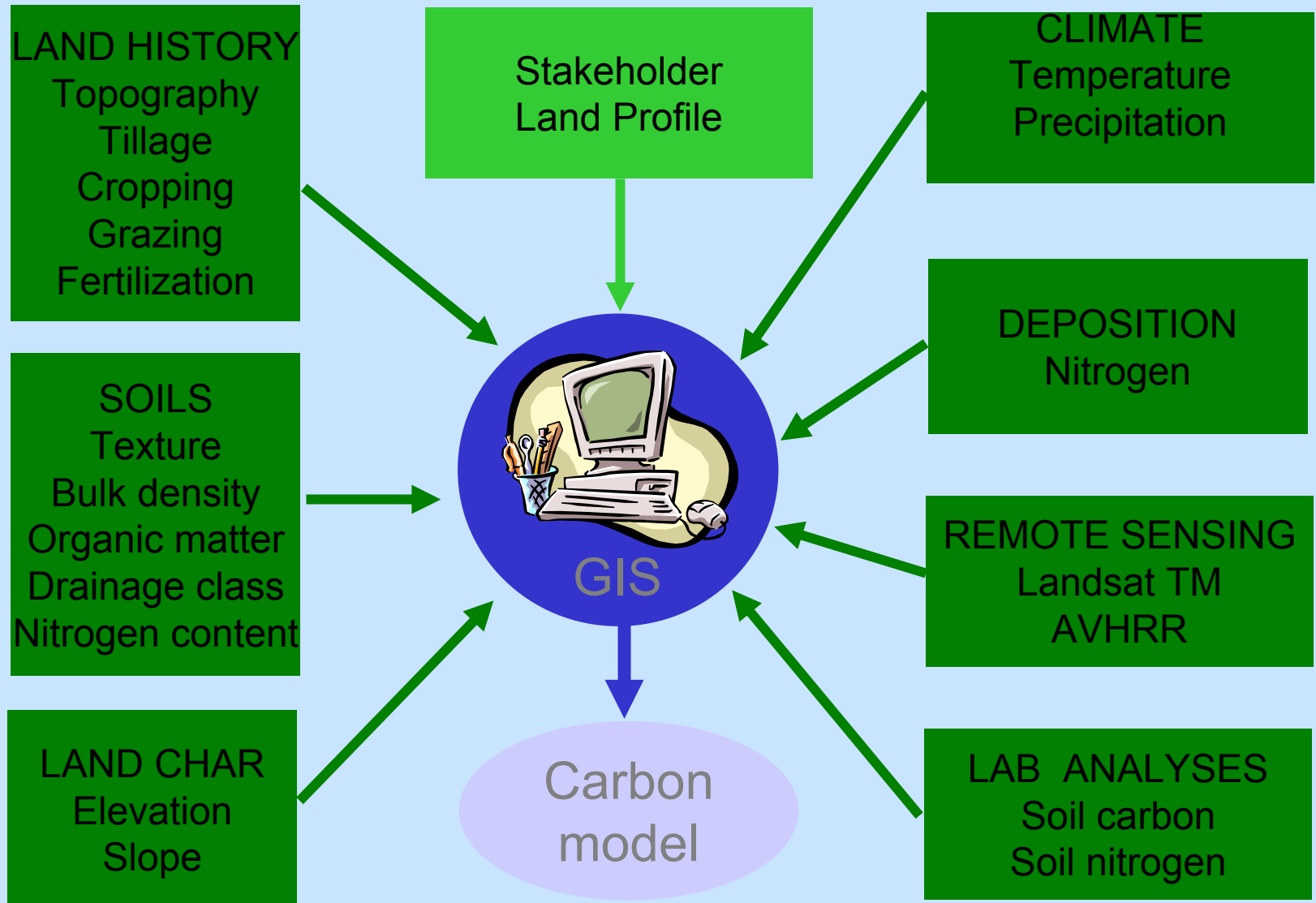
-- Two main goals:

Identify and assess Carbon Emission Reduction Credits (CERCs) for ag lands

Maximize the value of CERCs for producers through a system of validation and marketing

Issues considered in C-Lock:

- Establishment of Baseline
- Additionality, Surplus
- Permanence
- Leakage
- Ownership
- Verification

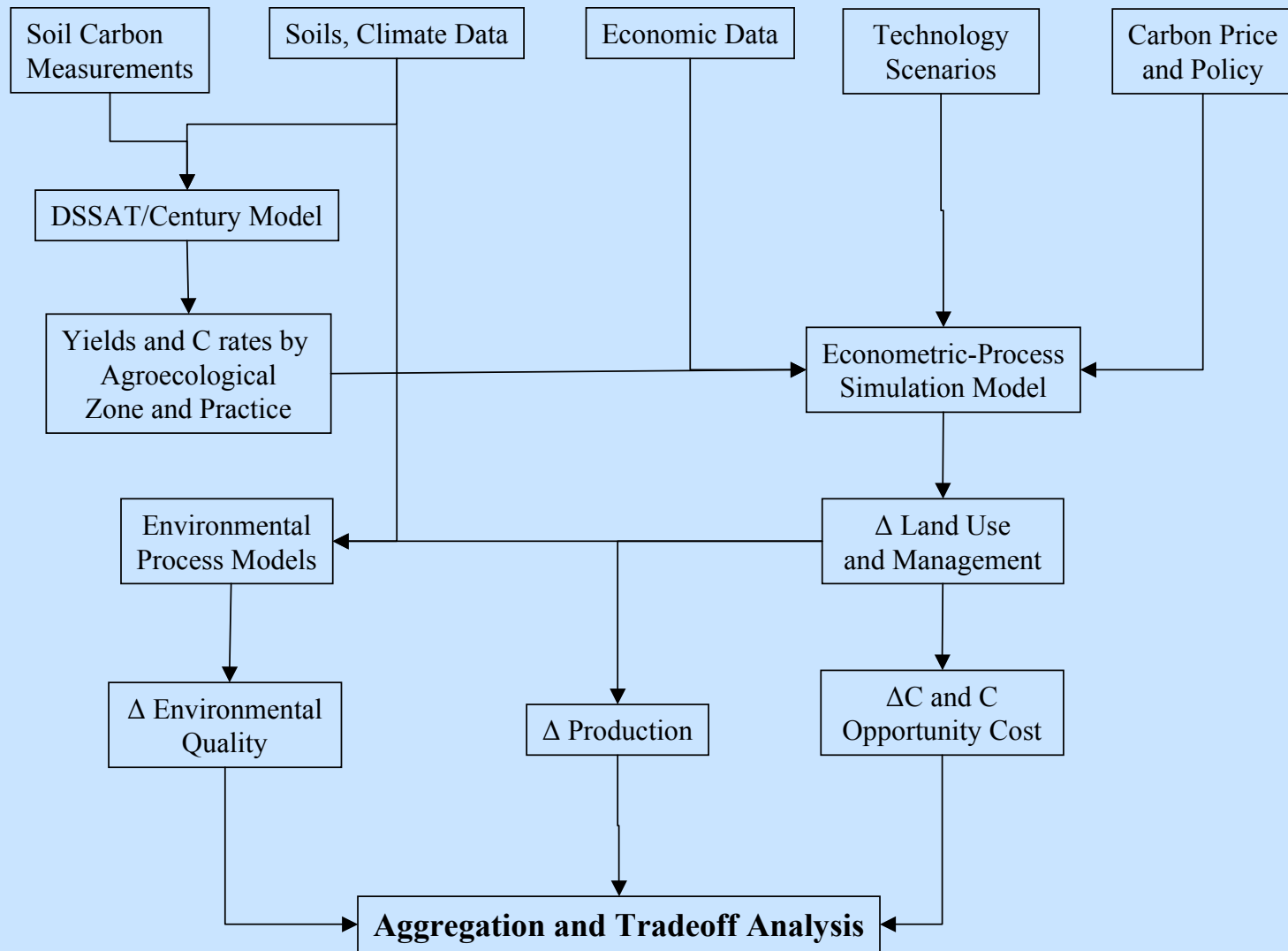


C-Lock provides:

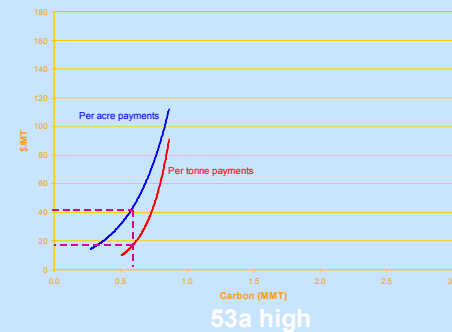
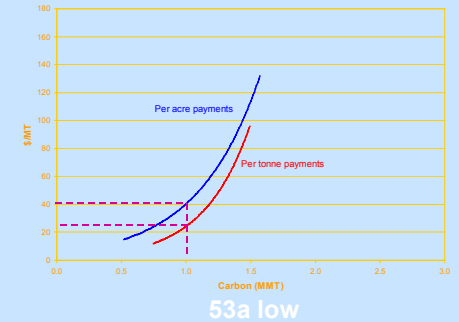
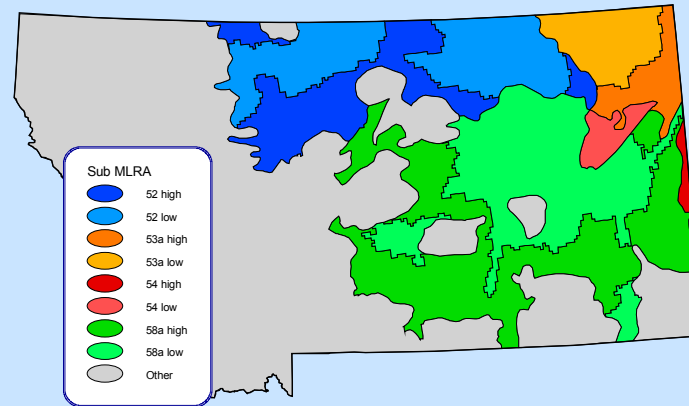
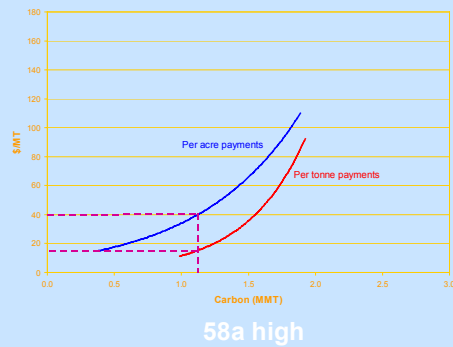
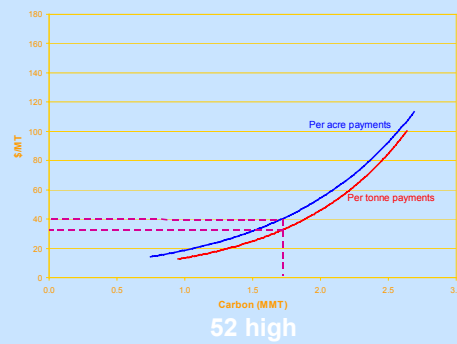
- ⌘ Process to address and define uncertainties
- ⌘ Emphasis on minimizes costs of sequestering soil C
- ☑ Flexible platform to interface regulations, science, and producer inputs and future changes
- ☑ Internet based system to enhance stakeholder interaction
- ☑ Provides online, near real-time estimation tools to help producers maximize sequestration potential
- ☑ Modules for forestry, manure management, landfills and erosion mitigation are under development for the partnership region

Integrated Assessment Paradigm for Evaluating Terrestrial Sequestration Potential – Montana model

- Economic data \Rightarrow
economic production models
- Soils & climate data \Rightarrow
crop ecosystem models
- Output of crop ecosystem models \Rightarrow
economic models and
environmental process models
- Output of economic models \Rightarrow
environmental process models



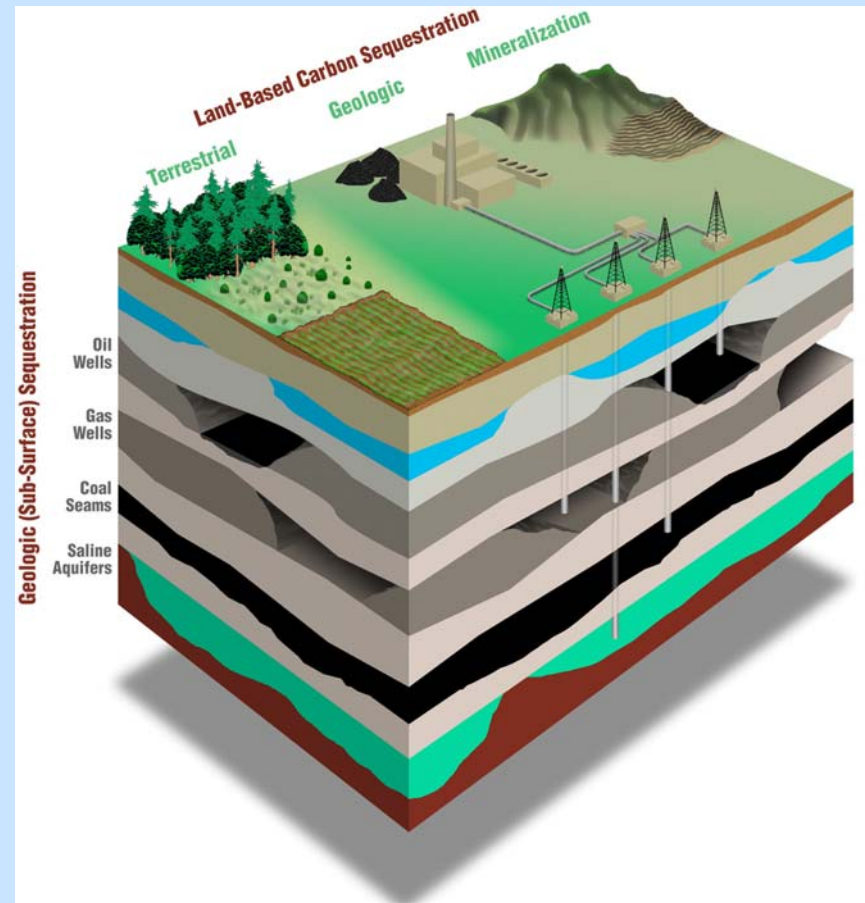
Terrestrial Carbon Sequestration Analysis



Marginal costs of sequestering additional soil C in selected areas of Montana

Advanced Concepts

- LANL Lead in Advanced Concepts
 - State of Sequestration and Gap Analysis (LANL Lead)
 - Common Evaluation of Various Sequestration Options (MSU Lead)
 - Identify Sequestration Guidelines (MSU Lead)
 - Sequestration Permit Issues (MSU Lead)
 - Revised 1605 B National Greenhouse Gas Registry
 - Cost Share Programs
 - Carbon Credit
 - Best Production Practices
- Mineralization Trapping
 - Engineered Mineralization Potential (LANL Lead)



Education and Outreach

Goals:

- **Increase awareness, understanding and acceptance**
- **Build advocacy**
- **Explore economic development opportunities**
- **Determine implementation barriers**
- **Establish networks of key constituencies**

EnTech Strategies, LLC

Pamela Tomski, ptomski@entech-strategies.com

Key Constituencies

- University Community
- Environmental NGOs and Professional Societies (ASME)
- Industry
- Farmers, Ranchers and Land Owners
- Native American Tribal Nations
- State Legislative and Regulatory Officials
- Congressional Delegations
- General Public

Education and Outreach

Tasks

- Outreach and Education Plan
- Partnership Listserve
- Brochure, Poster and Display
- Website
- Media Package and Campaign
- Community Roundtable Discussions
- Innovation Workshops
- Economic Development Workshop
- Capitol Hill Seminar for MT, ID, SD Delegations
- Carbon Sequestration Research Paper Competition (ASME)



***Future
meeting sites
for the
Northern
Rockies and
Great Plains
Regional
Partnership***

What is a ton of carbon dioxide roughly equivalent to?

- A. One cord of wood
- B. 24 grass hay bales (the ones we used to buck)
- C. One person's one--two week atmospheric impact:
 - Fuel, waste decay, manufacturing, energy use
- D. All of the above

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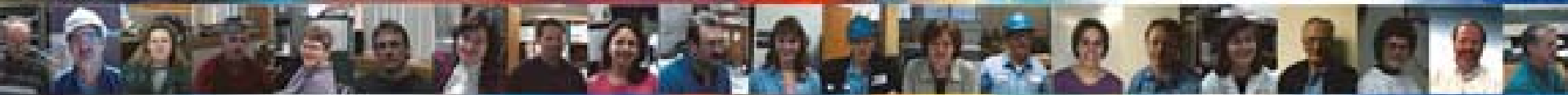


EERC Technology – Putting Research into Practice

Plains CO₂ Reduction (PCOR) Partnership

November 3, 2003

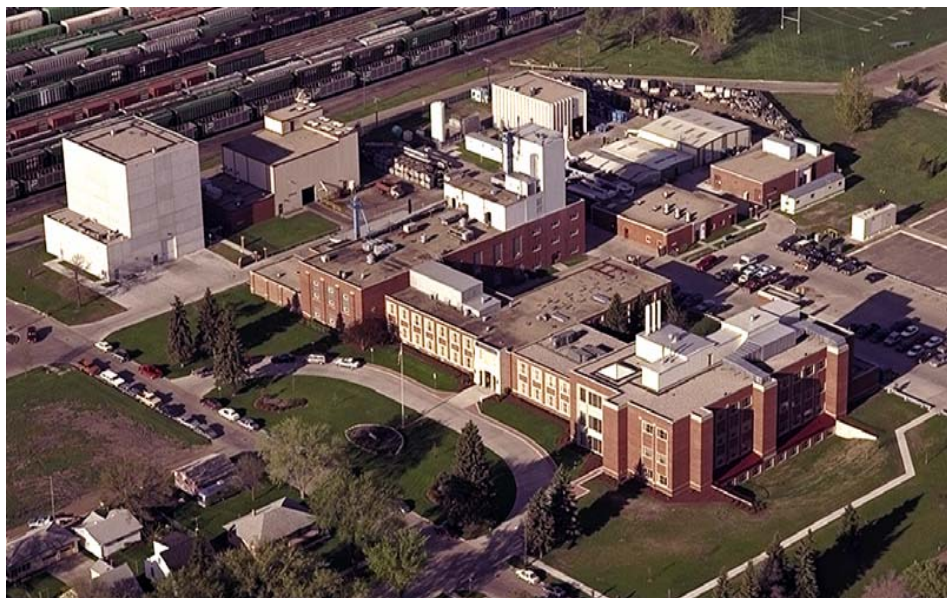
*Presented at the Regional Carbon Sequestration
Partnership Meeting
Pittsburgh, Pennsylvania*



University of North Dakota

About the EERC

The EERC is a research, development, demonstration, and commercialization facility recognized internationally for its expertise in:



- Cleaner, more efficient energy technologies.
- Air and water pollution prevention and cleanup.
- Water management.
- Contamination cleanup and site remediation.
- Waste management and utilization.
- Advanced analytical methods.
- Education and training.

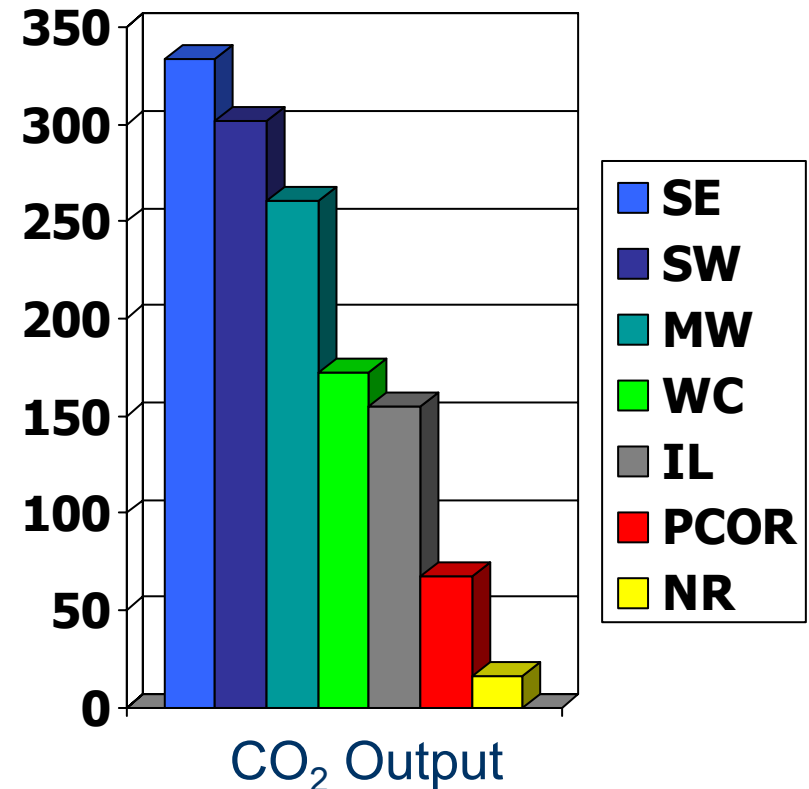


Plains CO₂ Reduction Partnership – Region



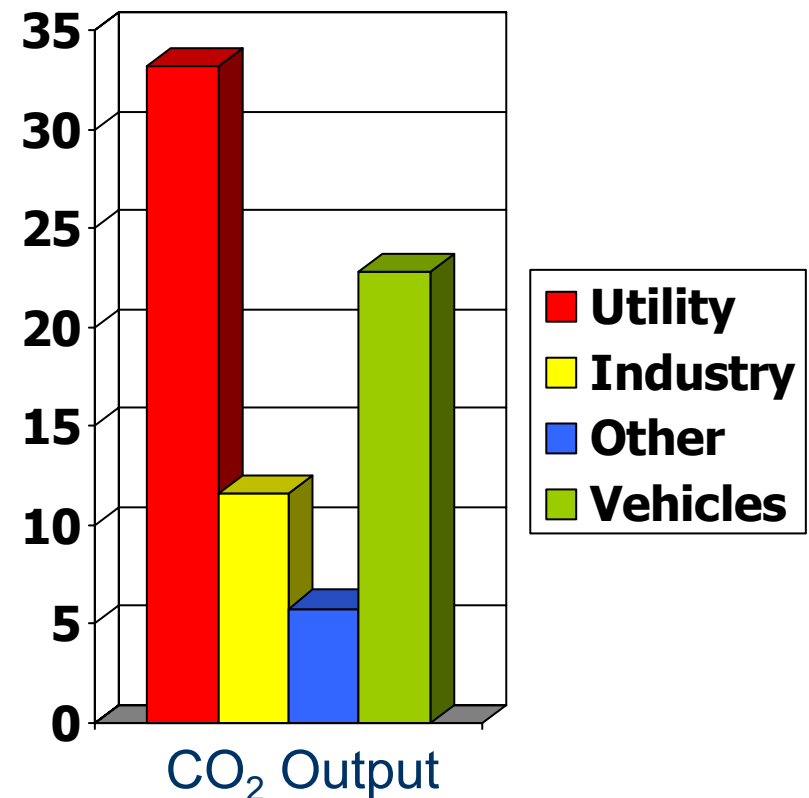
RCSP Regions – Energy-Related CO₂ Output

- Total U.S. energy-related CO₂ output = 1477 MMTCE/yr.
- RCSP regions account for 33 states and 79% of U.S. output.
- PCOR Partnership region ranks sixth among RCSP regions in CO₂ output.



PCOR Partnership Region – Energy-Related CO₂ Profile

- 67.6 MMTCE/yr regional CO₂ output
- 2/3 large stationary sources
- Region accounts for 4.6% U.S. total
- Geologic, value-added sequestration projects



Plains CO₂ Reduction Partnership – Sponsors



NDSU

North Dakota Industrial Commission



**Environment
Canada**



**Western
Governors'
Association**

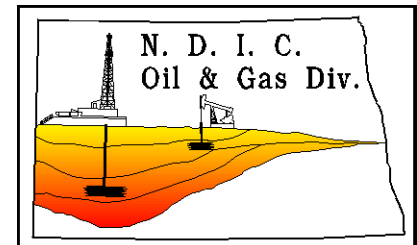


**Dakota
Gasification
Company**

Fischer Oil and Gas



**Minnesota Pollution
Control Agency**



Prairie Public Television

Interstate Oil and Gas Compact Commission

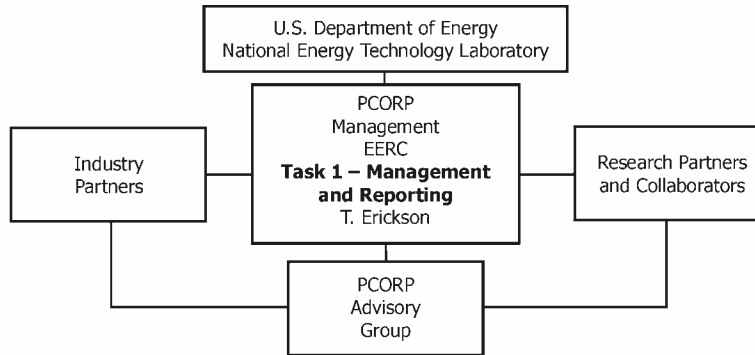
Plains CO₂ Reduction Partnership – Partner Contributions

		Task 1	Task 4			Task 2	Task 3	Task 5	
Role	Organization	Mgt., Reporting	Source	Sink	CO ₂ Separation and Transport	Regulatory Issues	Public Outreach	Technology Assessment	Action Plans
Project Management	EERC	P	P	P	P	P	P	P	P
Research Partners	DGC		S	S	P	S		S	S
	Fischer Oil and Gas			P		S		S	S
	Nexant-Bechtel				P	S		P	S
	North Dakota State University			P		S		S	S
	Prairie Public Television						P		
Industrial Sponsors	Basin Electric Power Cooperative, DGC, Montana-Dakota Utilities, Otter Tail Power, NDIC, Great River Energy		S			S	S	S	S
Collaborating Partners	State, provincial, and federal regulatory agencies; Western Governors' Association; Petroleum Technology Transfer Council; Amerada Hess, Environment Canada			S		P	S	S	S

Plains CO₂ Reduction Partnership – Funding

- U.S. Department of Energy \$1,586,000
- Industry sponsors (cash) \$ 360,000
- In-kind contributions \$ 800,000
 - Dakota Gasification – \$700,000
- Total project \$2,750,000

Plains CO₂ Reduction Partnership – Organization



EERC DD21484.CDR						
Task 2 Deployment Issues	Task 3 Public Perception and Outreach	Task 4 Characterization and Evaluation			Task 5 Modeling and Phase II Action Plans	
J. Harju (EERC)	D. Daly (EERC)	J. Sorensen (EERC)			T. Erickson (EERC)	
Environmental and Permitting Working Group	Public Perception and Outreach Working Group	Sources Working Group	Sinks Working Group	Separation and Transportation Working Group	Modeling Working Group	Action Plan Working Group
J. Harju (EERC)	D. Daly (EERC)	D. Laudal (EERC)	J. Sorensen (EERC)	M. Musich (EERC)	T. Erickson (EERC)	T. Erickson (EERC)
State Environmental Regulatory Offices – MN – ND – SD – WY EPA Environment Canada Dakota Gasification	Prairie Public Television Western Governors' Association Petroleum Technology Transfer Council ND Lignite Council	Dakota Gasification Basin Electric Montana-Dakota Utilities Otter Tail Power Great River Energy	NDIC OGD ND Geological Survey NDSU Fischer Oil & Gas Dakota Gasification ND Lignite Council Amerada Hess Corporation	Dakota Gasification NDIC Nexant-Bechtel	Nexant-Bechtel IOGGC NDOGC	Representation Chosen by the Work Groups
Technical Support Capabilities Data Management and GIS Capability, E. O'Leary (EERC)						

Task 1 – Program Management

- Overall program management
 - Subcontract management
 - Budget management
 - Communications with DOE
 - Communications with partners
-
- Coordination of Advisory Group and Working Groups

Advisory Group

- Comprises industrial sponsors, collaborating partners, and regional and national stakeholders
- Meets one to two times per year
- Provides guidance on the overall direction of the program
- Provides direction on additional information and activities that would support this project

Working Groups

- Comprised of members of the advisory group as well as research team members
- Provide direction on the specific research activities within the given topic
- Support the individual working groups through in-kind contributions

Task 1 – Completed and Future Activities

- Research kickoff meeting on October 22 in Grand Forks
- Dakota Gasification kickoff meeting in Beulah, ND, on October 23
- All partnering agreements near completion
- Pursuing new sponsors
- Invitations out to all Advisory Board members (25)

Task 1 – Completed and Future Activities (cont.)

- Presented to the Natural Resources Trust
- Presented to the ND Oil and Gas Council
- Presenting to the Basin members meeting November 5, Bismarck, ND
- Advisory Board kickoff meeting – December 11 and 12, Grand Forks

Technology Deployment



Dakota Gasification CO₂ Capture and Transport – EnCana Corp.
Weyburn Enhanced Oil Recovery



Task 2 – Technology Deployment Issues

- Safety, regulatory and permitting requirements
- Public perceptions
- Ecosystem impacts
- Monitoring and verification

Regional EOR Projects – Experience in CO₂ Transportation, Injection, and Monitoring

- Dakota Gasification – EnCana Weyburn field sites
- Anadarko CO₂ pipeline – Shute Creek gas-processing plant to Salt Creek, WY

Weyburn Project – Pipeline Map



CO₂ Supply
IEA Weyburn CO₂ Monitoring and Storage Project
Image courtesy of EnCana

Weyburn CO₂ Flood EOR Project – Key Information

- Location – near town of Weyburn, Saskatchewan
- Operating company – Encana Corporation
- CO₂ provider – Dakota Gasification Company
- 95 mmscfd (5000 metric tons/day) CO₂ from DGC contracted and injected
- CO₂ purity 95%
- EnCana currently injects 120 mmscfd (21% recycle)
- Incremental oil >5000 bbl/day
- CO₂ injection started September 2000
- 70 billion cubic feet (bcf) CO₂ injected as of September 2003

Task 2 – Completed and Future Activities

- Reviewing DGC and other regional activities for baseline information
- Organizing working groups
- Developing the two-year work plan

Public Outreach



Task 3 – Public Outreach

- Create informed stakeholders in the PCOR Partnership region
 - Successful sequestration projects require public acceptance.
 - Sequestration is a new, relatively unknown strategy.
 - Effective communication of benefits and risks associated with sequestration strategies is the basis for public acceptance.

Approach

- Public outreach/education working group
- Public outreach/education plan
- Conduct public information campaign
- Gauge level of public understanding
- Coordinate with and build on DOE's RCSP efforts and local partner efforts

Task 3 – Completed and Future Activities

- Initial PCOR Partnership fact sheet
- Developing two-year work plan
- K-12 educational packages
- Newspaper series
- 30-minute video
- Series of fact sheets

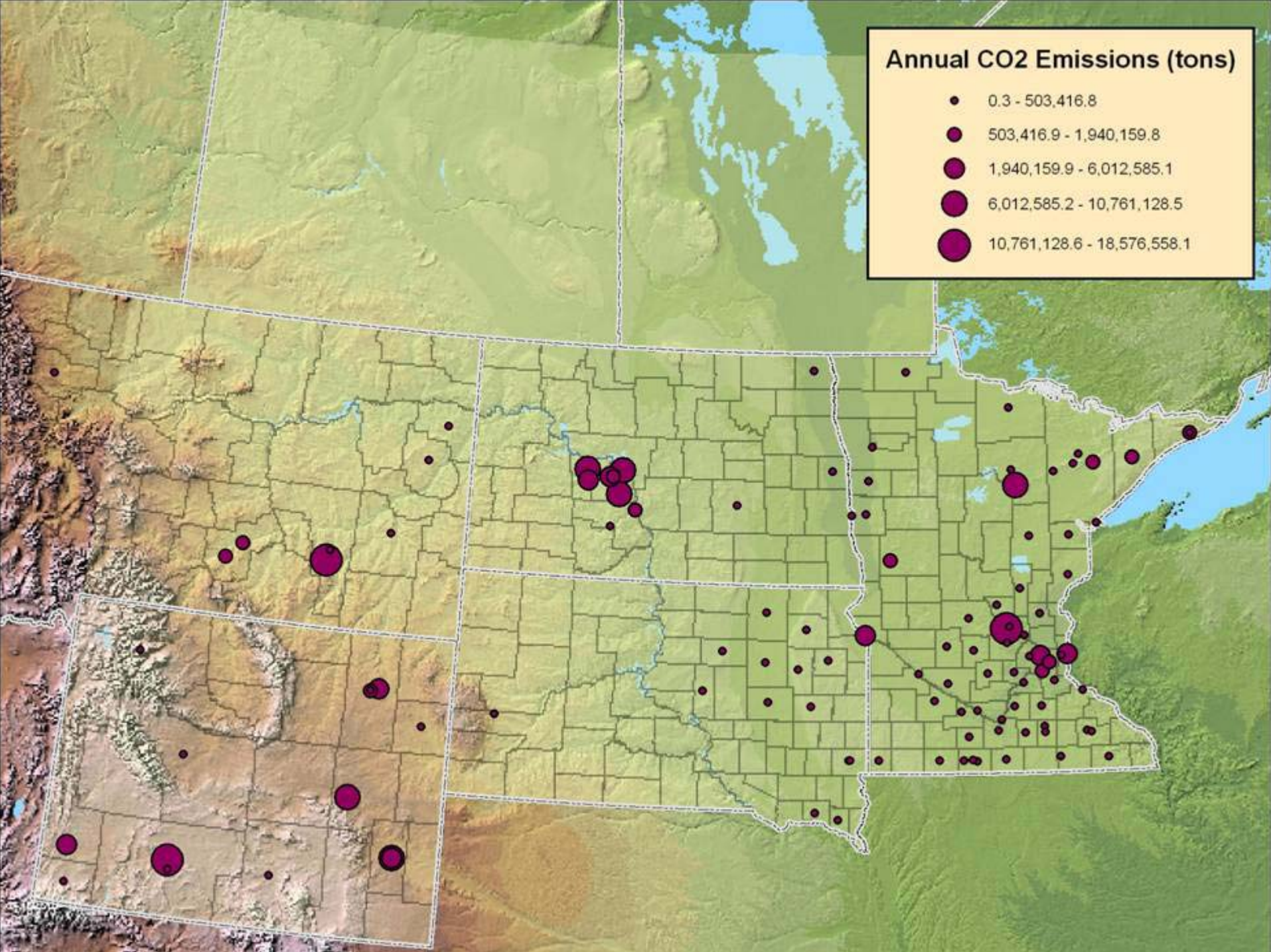
Task 4 – Sources, Sinks, and Infrastructure

Source Characterization

- Sources to be evaluated
 - Coal-fired power plants
 - Great Plains Gasification Plant
 - Ethanol production facilities
 - Oil refineries
 - Natural gas-processing plants

Annual CO2 Emissions (tons)

- 0.3 - 503,416.8
- 503,416.9 - 1,940,159.8
- 1,940,159.9 - 6,012,585.1
- 6,012,585.2 - 10,761,128.5
- 10,761,128.6 - 18,576,558.1



Task 4 – Sources, Sinks, and Infrastructure

Source Characterization

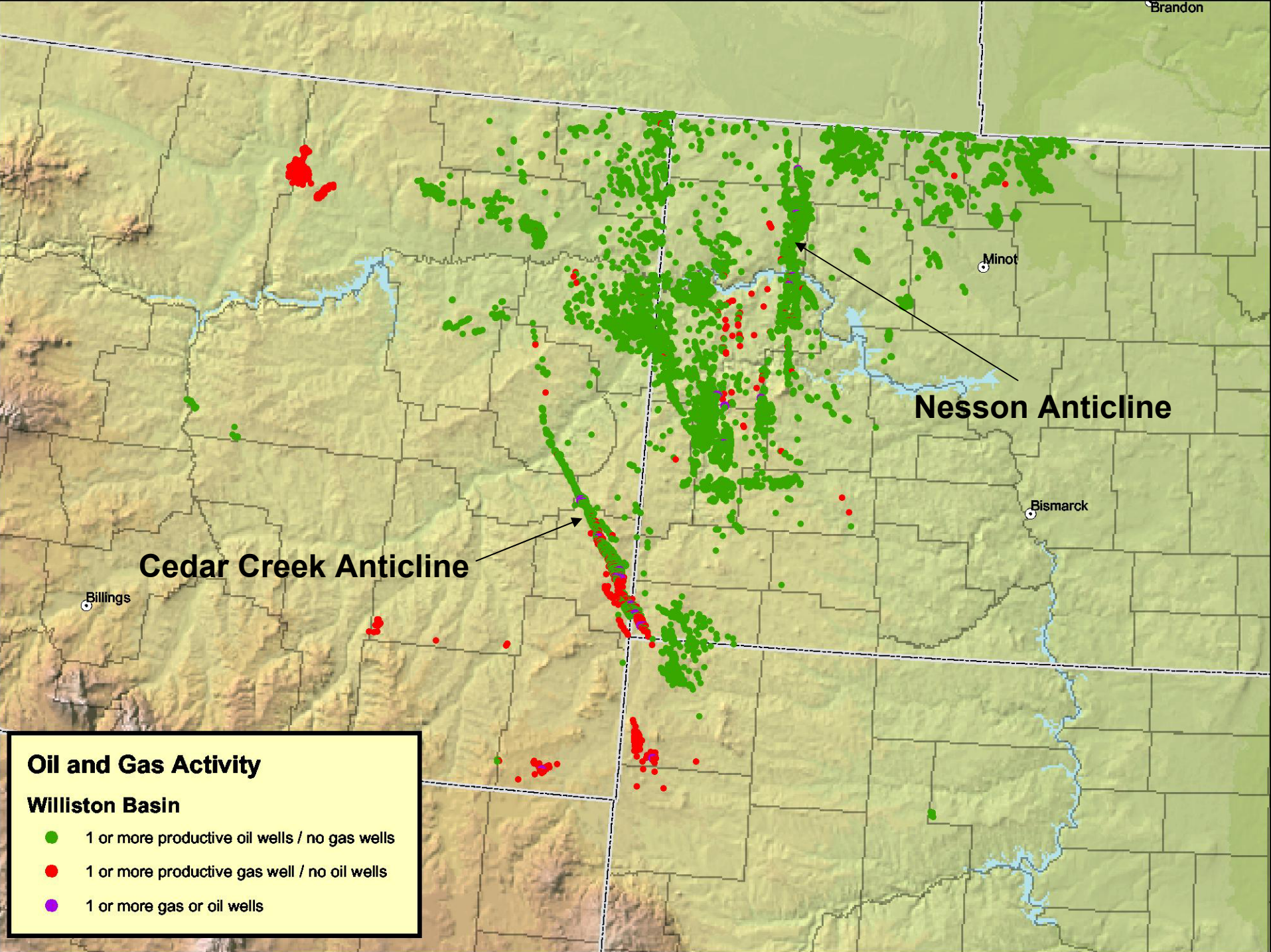
- Sources to be evaluated, continued
 - Taconite plants
 - Paper mills
 - Sugar plants
 - Cement plants
 - Waste incinerators
 - Manufacturing plants

Task 4 – Sources, Sinks, and Infrastructure

Sink Characterization

- Geologic sinks
 - Petroleum reservoirs with potential for enhanced oil or gas recovery (EOR and EGR)
 - Weyburn CO₂ EOR project
 - Depleted petroleum reservoirs
 - Deep brine formations
 - Unminable coal beds
 - Coal seams with potential for enhanced coalbed methane recovery (ECBM)

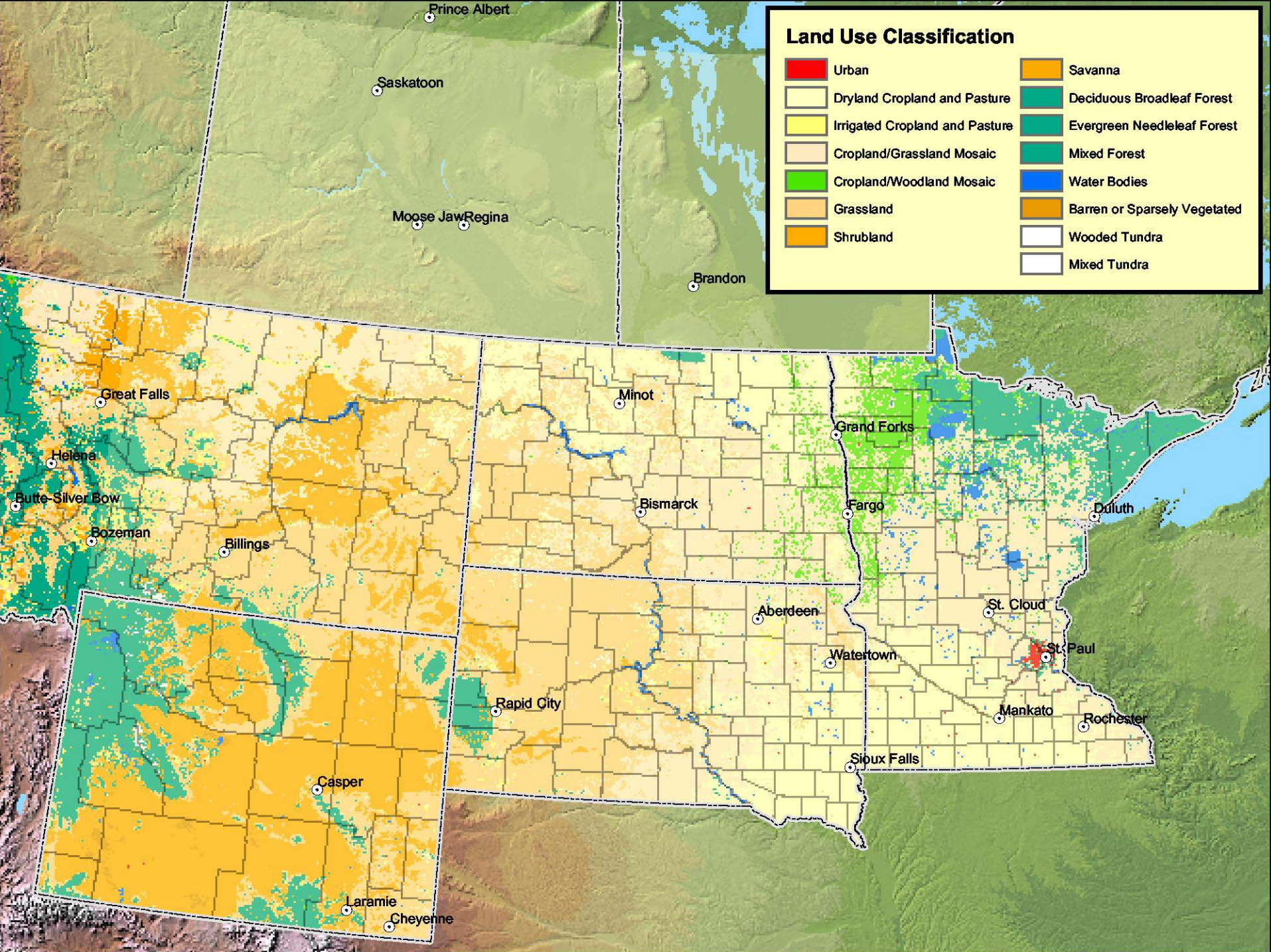




Task 4 – Sources, Sinks, and Infrastructure

Sink Characterization

- Terrestrial sinks
 - Current agricultural land uses
 - Crop types
 - Management practices
 - Alternative land use and agricultural practices
 - Forests



Task 4 – Sources, Sinks, and Infrastructure

Infrastructure Characterization

- Separations
- Gas Cleanup
- Transportation

Task 4 – Completed and Future Activities

- Developed data-gathering standards and quality assurance measures
- Initiated data gathering for all activities
- Developed internal database and GIS Web site

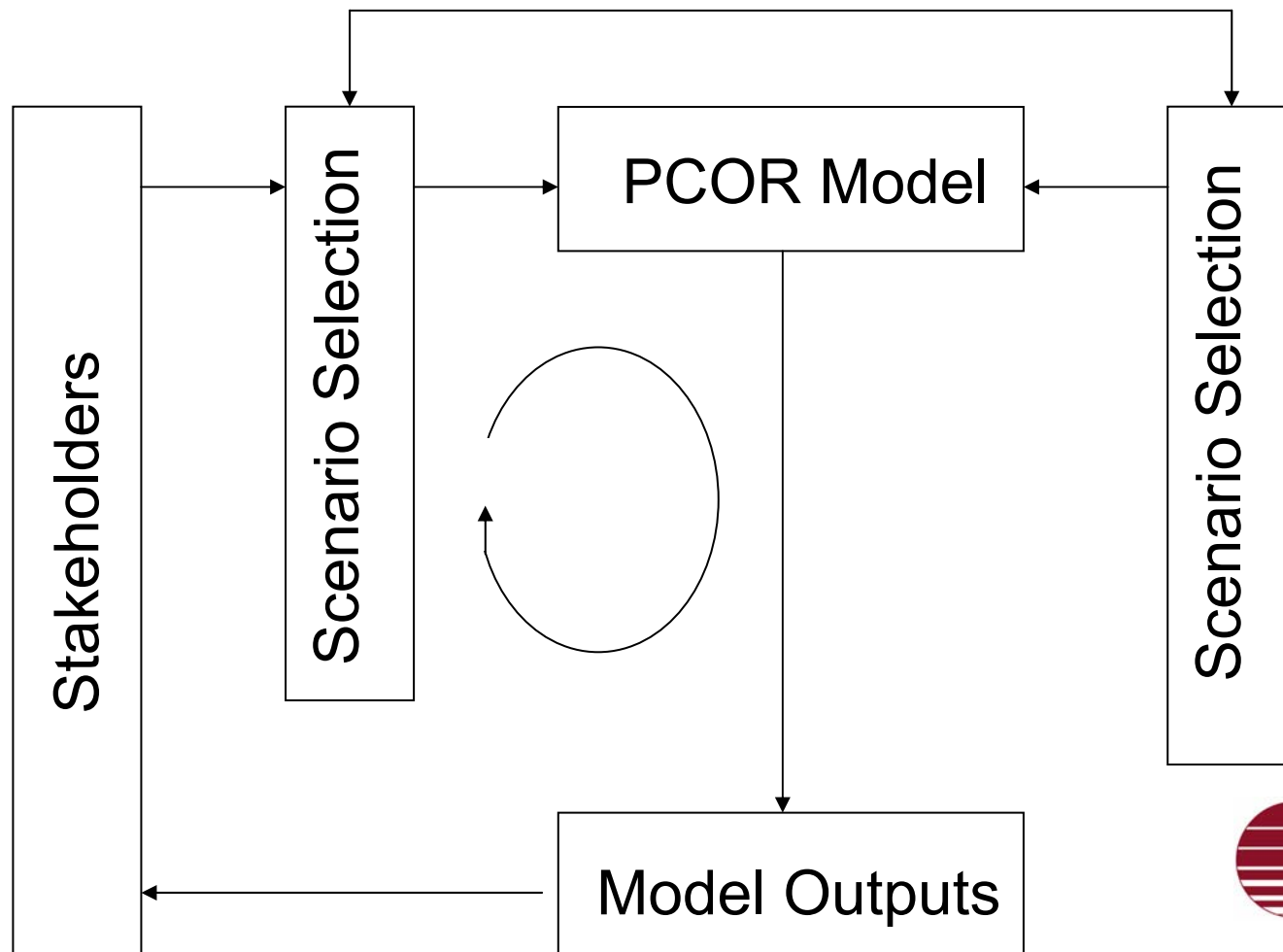
Task 5 – Modeling

- Model vs. Modeling Approach
 - Model – the way in which you process the given information to generate a series of answers.
 - Model approach – the way we feed the model the information and refine its application through iterations.

PCOR Partnership Model



Modeling Approach



Task 5 – Completed and Future Activities

- Currently developing model functions.
- Upon completion of model first draft, we will run a baseline on DGC–Weyburn activities.

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Appendix C

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Regional Carbon Sequestration Partnership Kickoff Meeting
November 3, 2003 - November 4, 2003

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November 3, 2003 - November 4, 2003

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